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TURNING AND FITTING TAPERS.

By Joshua Rose.

In turning tapers in a lathe in which there is no provision for taper-turning, save by setting over the tail-stock, it is impracticable to determine the amount of such set-over by calculation, nor is there any practical method of setting such a lathe to the exact required taper without trying and fitting the work, the reasons being as follows: Supposing the tail-stock to be provided with a scale or rule-marks, whereby to measure the amount of set-over, and, therefore, of taper in a given length, the least variation in the length of the work would vary the proportion of taper with the same amount of set-over; then, again, the position of the taper part of a rod is an element to be considered in connection with the length of the rod upon which the taper is to be cut; especially is this latter the case, because in a majority of cases a taper does not run from end to end of a rod. The main elements of a calculation to determine the amount of set-over for a required taper would be, the distance between the lathe-centres and the amount of taper in a certain length. The first requires a minute and difficult measurement as to how far the lathe-centres enter the work in the first place, while in the second it varies as the cutting proceeds, because of the excessive wear which takes place in turning tapers by setting the tail-stock over. The cause of such excessive wear is that the tail-stock of the lathe, when set over, stands parallel with the centre-line of the length of the lathe-bed or shears, while the centre-line of the work, when placed between the lathe-centres, does not stand parallel with those shears, thus causing excessive wear on the centres of both the lathe and the work. If we notice the dog fastened to a piece of work placed in the lathe and revolved while the tail-stock of the lathe is set over, we shall find that the head of the dog or driver recedes from the face-plate of the lathe during one half, and approaches it during the other half, of the revolution, showing that the dog, and hence the work, is not revolving in the same plane as is the face-plate of the lathe. As a consequence, each of the lathe-centres is on one side bearing on the outer diameter of the cone in the centre of the work; while, on the other side, it is bearing on the inner or smaller diameter of the cone or countersink of the centre of the work, as shown in Fig. 1, in which A and B represent the lathe-centres, and C a section of a piece of work set over to be cut taper. At D and E the lathe-centres are bearing on the inner, and at F and G at the outer, diameter of the centres in the work.

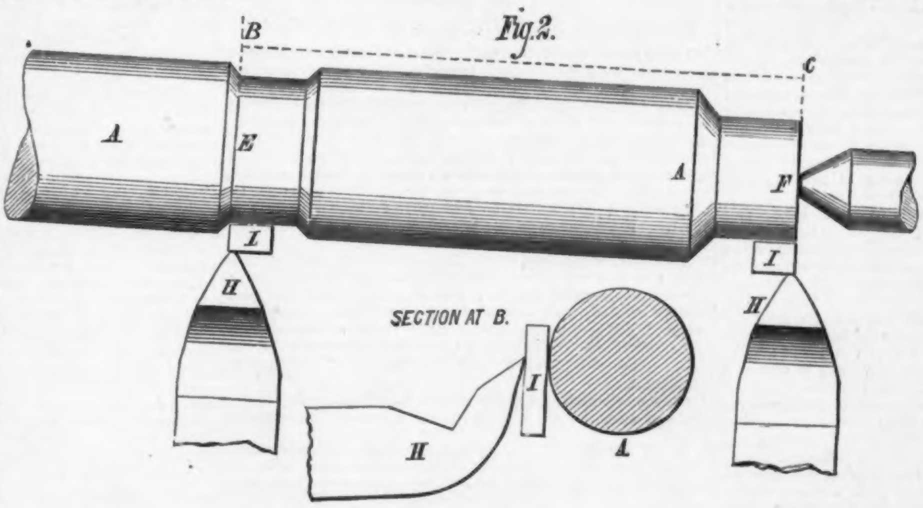
In soft metals the wear (from the above causes) of the work-centres being excessive, the work is very apt to get out of true as the wearing proceeds, and to keep varying in its centres, rendering it very difficult to finish it true; so, also, in cast iron, which abrades very easily upon the lathe-centres, the work is apt to become untrue. Wrought iron does not suffer so much unless it is seamy or there are soft or hard spots or parts in it, in which case it is impossible to keep it true. In steel work but little difficulty is experienced, because the homogeneity and texture of the metal are sufficiently even and close to resist the tendency to abrasion.

There is, however, in the case of any metal, another thing to be considered, which is, that no work can be turned true in the lathe unless all the surfaces requiring to be turned up are roughed out before any one part is finished (as has been already explained in a previous article published in this journal), so that in turning up a piece of work having a plain and a taper part, we are confronted with the following considerations:

If we turn up and finish the plain part first, the removing of the skin and the wear of the centres during the operation of turning the taper part, will cause the work to run out of true, and hence it will not, when finished, be true; or, if on the other hand, we turn up the taper part first, the same effects will be experienced in afterwards turning the plain part. We may, it is true, first rough out the plain part, then rough out the taper part, and finish first the one and then the other; to do this, however, we shall require to set the lathe twice for the taper and once for the parallel part—the latter, for long parallels, being a long and tedious operation, especially if the tail-stock has no scale or mark-line whereby to denote when it is set parallel, while, even if it has such a mark, it is scarcely practicable to set it dead-true at the first trial, hence it becomes necessary to take a fine trial cut, entailing therefore that much extra labor. The tail-stocks of lathes designed to turn tapers by having the tail-stock set over, should be provided with a taper pin-hole and pin, the one neatly fitted to, and ground into, the other, and located so that the tail-stock will be in position to turn parallels when the pin is driven lightly home.

It is found in practice that the work will be more true by turning the taper part the last, because the work will alter less upon the lathe-centres when changed from parallel to taper turning, than when changed from the latter to the former. In cases, however, in which the parts fitting the taper part require turning, it is better to finish the parallel part last, and to then turn up the work fastened upon the taper part while it is fast upon its place; thus in the case of a piston-rod and piston, were we to turn up the parallel part of the rod first and the taper last, and the centres altered during the last operation, when the piston-head was placed upon the rod, and the latter was placed in the lathe, the plain part or stem would not run true, and we should require to true the centres to make the rod run true before turning up the piston head. If, however, we first rough out the plain part or stem of the rod, and then rough out and finish the taper part, we may then fasten the head to its place on the rod, and turn the two together; that is to say, rough out the piston head, then finish the rod, and subsequently the head; thus will the head and rod be true together, whether the taper is true with the parallel part of the rod or not.

Fig. 2.

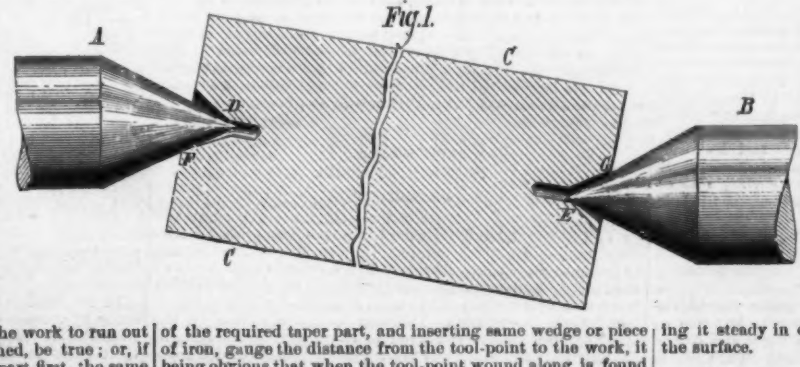


The easiest way to set a lathe tail-stock for a required taper is as follows:

If we have a pattern we may place the same in the lathe-centres, and fasten a tool in the lathe tool-post, and set over the tail-stock until the point of the tool moved along with the slide-rest will just touch the taper of the pattern evenly from end to end.

If we have no pattern, we may turn the part requiring to be taper parallel at each end, leaving it, say $\frac{1}{32}$ inch larger than the required finished size. We then fasten a tool in the lathe tool-post, place it so that it will clear the metal of the part requiring to be turned taper, and placing it at one extreme end of said part, we take a wedge, or a piece of metal sufficiently thick, and place it to just contact with the turned part of the work and the tool point (adjusting the tool with the cross-feed screw), we then wind the test to the other end of the required taper part, and inserting same wedge or piece of iron, gauge the distance from the tool-point to the work, it being obvious that when the tool-point wound along is found to stand at an equal distance from each end of the turned part, the lathe is set to the requisite taper. Fig. 2 illustrates this method of setting.

Fig. 1.



In Fig. 2, A A represents a piece of work requiring to be turned taper from B to C, and turned down to within $\frac{1}{32}$ inch of the required size at E and F. If then we place the tool-point H first at one end and then at the other, and insert the piece I and adjust the lathe so that the piece of metal I will just fit between the tool-point and the work at each extreme end of the required taper part, the lathe will be set to the requisite taper as near as practicable without trying the work to the taper hole.

Lathes having compound slide-rests (in which case the top slide of the rest may be set to the required taper without the tail-stock being moved) may be set by the tool tried with the pattern, as already described, or by following the plan shown in Fig. 2. In the case of having a pattern, however, it will save a little time to place the pattern between the lathe-centres, and move the top slide of the rest by hand until the eye levelled, so as to bring the outline of the taper and the edge of the top slide close together, judges the one to be parallel with the other. Hand slide-rests may be set in like manner, and when the latter require to be set parallel they may be adjusted nearly true by bringing the edge of the slide-rest slide parallel with the edge of the lathe-bed, or with the edge of the V slides of the lathe-bed.

To try a taper into its place, we either make a chalked stripe along it from end to end, smoothing the chalked surface with the finger, or else apply red marking to it, and then while pressing it firmly into its place, revolve it back and forth, the while holding it firmly to its seat in the hole; we move the longest outwardly projecting end up and down and sideways, carefully noting at which end of the taper there is the most movement. The amount of such movement will denote how far the taper is from fitting the hole, while the end having the least movement will require to have the most taken off it, and the fulcrum off which the movement takes place is the highest part, and hence requires the greatest amount of metal to be taken off it.

Having fitted a taper as nearly as possible with the lathe tool, that is to say, so nearly that we can not find any movement or unequal movement at the ends of the taper (for there is to be movement if the hole chance to be rounding in the outline of its length) we must finish it with a smooth file as follows: After marking the inside of the hole with a very light coat of red marking, taking care that there is no dirt or grit in it, we press the taper into the hole firmly, forcing it to its seat while revolving it back and forth while still advancing it gradually forward, so that the movement is a reciprocating and yet a revolving one, at least two complete revolutions of the taper having been made in the hole. The work must then be run in the lathe at a high speed, and a smooth file used to ease off the mark visible on the taper, applying the file the most to parts or marks having the darkest appearance, since the darker the marks the harder the bearing has been. Too much care in trying the taper to its hole can not be taken, since it is apt to mark itself in the hole as though it were a correct fit when at the same time it is not; it is necessary therefore at each insertion to minutely examine the fit of the lateral and vertical movement of projecting part of the taper, as above directed.

A taper or cone should be fitted to great exactitude before it is attempted to grind it, the latter process being merely intended to make the surfaces even.

For wrought-iron, cast-iron, or steel work, oil and emery are used as the grinding materials (for brass, burnt sand and water are the best). The oil and emery should be spread evenly with the finger over the surfaces of the hole and the taper, the latter should then be placed carefully in its place and pressed firmly to its seat while it is being revolved back and forth, and slowly rotated forward by moving it farther during the forward than during the backward movement of the reciprocating motion.

After about every dozen strokes the taper should be carefully removed from the hole and the emery again spread evenly over the surfaces with the finger, and at and during about every fourth one of the back strokes of the reciprocating movement the taper should be slightly lifted from its bed in the hole, being pressed lightly home again on the return stroke, which procedure acts to spread the grinding material and to make the grinding smooth and even. The emery used should be about number 60 to 70 for large work, about 80 to 100 for small, and flour emery for very fine work.

Any attempt to grind work by revolving it steady in one direction will cause it to cut and destroy the surface.

MONSTER ENGINE.

Messrs. Douglas & Grant, Engineers, of Dunnikier Foundry, Kircaldy, recently exhibited, running under steam, a patent compound Corliss engine of 1000 horse-power, and capable of working up to double that power. This engine, the largest for land purposes ever manufactured in the county of Fife, is intended to drive the machinery of a cotton-mill at Bombay, and will be the third of the same kind sent to that country by this firm within a recent period. The diameter of the high-pressure cylinder is 40 inches, and the low-pressure cylinder, 66 inches, both being 6-feet stroke. The crank-shaft, which is of steel, weighs about 5 tons, its neck being 16 inches in diameter and 24 inches long. The weight of the cylinder is upwards of 23 tons, the fly-wheel 46 tons, and the whole engine over 200 tons.

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QUEENSLAND (AUSTRALIA) AT THE CENTENNIAL.

FEW countries represented at the great Centennial gathering of nations offer more substantial inducements for the attention of American manufacturers, merchants, and mechanics than Queensland, the most northern of the Australian group of colonies. The area of country represented by the exhibits now in the Centennial buildings is immense. The products are amongst the most valuable in the mineral, animal, and vegetable kingdoms. Queensland is not a manufacturing country, although amongst the exhibits are highly interesting specimens of wood-work in mosaic, printing, bookbinding, manufactured silk, handsome photographs of nature, men, and manners in this far-distant land. But these are sent for exhibition only. The senders but desired to show their American brethren that the skilful hand of the educated workman does not lose its cunning even in the antipodes. The "stronghold" of Queensland is in the immense deposits of tin, copper, coal, gold, and other minerals found in the country, and also in the wool, sugar, arrowroot, and timbers, that are each amongst the best of their class known. These articles, with a large and striking collection of illustrations of the every-day life of colonists, and of scenes in the colony, make up the bulk of the Queensland exhibits. They are sent with no niggardly hand. All the articles mentioned are shown in bulk (in an exhibition sense), with an evident as well as an expressed determination to show American manufacturers and others the immense masses of raw material awaiting their attention in Australia.

The wool sent is about, if not the very best of its kind. But it is a fair sample, we are assured, of this staple as produced in Queensland, where 14,000,000 of sheep are pastured on the indigenous grasses, without any protection whatever, and are shorn yearly, the annual wool-clip of the colony being nearly 50,000,000 lbs. Tin is another huge product of Queensland. For the first time during centuries tin is a plentiful metal in our markets; at length the supply of this highly valuable metal is in excess of the demand. Tin of the finest quality (assaying from 93 to 97 per cent of pure metal) is almost a drug in our midst at present. It is with the idea of attracting the acknowledged inventive and ingenious faculties of Americans that the Queenslanders were induced to exhibit their refined tin so largely. They hope that Americans will see outlets for this metal in new branches of industry.

There are many other things of great interest and mercantile value in the Queensland Court, and there is a systematic, matter-of-fact business simplicity about all the arrangements that can not fail to instruct all who desire to know more of our gigantic young neighbor across the Pacific.

In order to be on hand all the time, the Commissioner, Mr. Angus Mackay, has his office in the midst of the exhibits of his fellow-colonists, and by the distribution of printed matter, explanation of illustrations, maps, charts, etc., the inquirer learns what he desires in a very short time.

The timbers sent for exhibition are a notable feature of the collection in the Queensland Court. There are over 300 varieties in all, the *Eucalyptus* tribe being fully represented. In California these timbers have already a habitation and a name, and amongst other references to the exhibits in the Queensland Court, we hope soon to give a full description of the varieties of *Eucalypti* now growing in California, with the uses of their timber, etc., etc.

EXHIBITION IN FINLAND.

ON the 1st of July this year, an Exhibition of Art, Manufactures, Agriculture, etc., will be opened at Helsingfors, the capital of Finland. The articles to be exhibited are such as are produced or manufactured in the country, with the exception of machinery, chiefly such as is used for agricultural purposes, which foreign firms having agents in the country will be permitted to exhibit. This will be the first exhibition of the kind in Finland. The exhibition will close on September 15th. The Emperor of Russia, who is Grand Duke of Finland, will visit his Finnish subjects on this occasion. It is to be hoped that the usual difficulties of getting into or getting out of Russian territory will be lessened, if for this time only.

SINGULAR CASE IN DENTAL SURGERY.

By DR. ADAMS PARKER.

A LADY consulted me in November last under the following circumstances. She complained that for the last five or six months she had suffered continual pain night and day in the left side of the face, and more particularly on the top of the head. There was no toothache, nor could she identify the pain in connection with any tooth. Furthermore, a very careful examination of all the teeth on the affected side failed to detect the slightest trace of caries. On the same side the first bicuspid tooth was absent, the second bicuspid was turned half round, so that the outer cusp was presented to the first molar and the inner cusp to the canine, and immediately over this tooth was to all appearances a very small piece of necrosed bone, quite firm, and the most minute investigation failed to detect any thing in the nature of a tooth or stump. There had been no blow, no recollection of any fall, or injury of any character that could account for it.

Upon my suggesting that it was a case that should come under the more immediate care of a surgeon than that of a dentist, she informed me that she believed there was the stump of a tooth there, for some twelve years previously a tooth grew out from the gum horizontally, and directly over the second bicuspid. This decayed very early and broke off, leaving no after ill-effects.

Such a communication as this led, of course, to a further search for the missing fangs without any corresponding success, when I determined upon an operation, the result of which proved satisfactory.

I made an incision over the second bicuspid, laying bare the alveolar process, and placing my thumb against the lingual surface to prevent loosening the tooth, firmly pressed a straight elevator into the cavity by the side of the small portion of necrosed bone, when, without the slightest further movement of the instrument, two small fangs, joined together, evidently those of the first bicuspid, slipped into the mouth. The diagnosis of the case was now complete; the opening caused by this almost painless operation was plugged with cotton-wool saturated with styptic colloid, and the patient sent home, and ordered to remove the wool and frequently rinse the mouth with warm water.

Remarks.—This case calls for one or two remarks, the most important of which is the necessity for making very careful and even long examinations of all teeth when pain in the neighborhood is supposed to have its origin in one or more of them, before resorting to any extreme measures. In this case a very searching one had been instituted, and nothing could be found to indicate the cause of so much suffering. If the patient had failed to mention the fact of the early-decayed tooth (her age at the time of its decay being only fourteen), I do not see any justification for an operation on the part of the dentist; but having done so, and the partial knowledge of the patient that a stump was somewhere about, no doubt could exist as to the propriety of one, for in the absence of something being done at this period of the case, in all probability at some future time an operation of a more formidable character would have had to be performed to arrest disease that must have inevitably communicated itself to the surrounding parts. Another curious phase in the history of this case was the almost total absence of pain for nearly twelve years after the breaking off of the tooth, and the continuous agony for nearly six months previous to my attending her.

The patient's medical adviser, Dr. Sharpe, of Walsall, reports that she has made a complete recovery.—*The Lancet.*

GELSEMIUM SEMPERVIRENS IN NEURALGIA.

THIS article, which has had reputation in this country for neuralgia, has attracted little attention in Europe. It has been recently tried at the Dispensary at Heidelberg by Dr. Jurasz, assistant physician, who has reported favorable results. Five minims of the tincture were given three times a day for three days to a man æt. thirty, who had been suffering for a week with neuralgia of the right supra-orbital nerve, which had resisted quinia and veratria treatment, and completely cured him. The same dose given for six days gave permanent relief to a woman who had had brachial neuralgia on the left side for more than a year and a half, and been treated with various other remedies without success.

Two other neuralgias of the fifth nerve were rapidly cured with five and ten-minim doses; and a case of very severe sciatica on the right side in a man of sixty, which had completely disabled him and confined him to bed, was quickly relieved by eight-minim doses three times a day, and the patient was able in a fortnight to walk with a stick; the cure being completed by warm baths and the use of the constant current.

On the other hand, the gelsemium failed completely in two cases of muscular rheumatism, and in a case of long-standing hemicrania.

In no instance was any unpleasant effect observed, either on the circulatory or digestive organs; but the dose of twenty minims was never exceeded.—*American Journal of the Medical Sciences.*

REMEDY FOR HEMORRHAGE.

IN all cases of hemorrhage following tooth-extraction so profuse as to require attention, the coagula must first be removed from the socket and surrounding parts. Then having at hand a saturated solution of common salt in pure cider-vinegar and some fine lint (such as may be procured by scraping an old linen table-cloth), dip a portion of the lint into the solution and carry to the bleeding socket, previously cleansed, and gently pack it in until the place left vacant by the root or roots is entirely filled. Then lay a strip of muslin folded so as to serve as a compress over the lint, and request the patient to close the mouth and make gentle pressure upon it. In ten or fifteen minutes the compress may be removed, the lint being allowed to remain until nature casts it out.

In a case which occurred in my practice, on a simple examination being made with a lance to determine the propriety of extracting a broken tooth, an inferior molar—the extraction not being attempted because of insufficient light—the hemorrhage which followed and persisted during the entire night to an alarming extent was promptly arrested in the morning by the above application. I see no reason why it might not be resorted to in a more general way as a styptic.—THOMAS WARDLE, M.D., D.D.S.—*Dental Cosmos.*

[The Academy.]

SCIENCE NOTES.

PHYSIOLOGY.

Decomposition of Albumen.—A variety of observations made by Voit have rendered it in the highest degree probable that the albuminoid matters contained in the body are not all equally liable to destructive change. The azotized constituents of the living tissues and organs are relatively stable, and furnish but a small proportion of the total amount of nitrogen eliminated from the system. The unorganized albumen, on the other hand, which is conveyed to every part of the body in the nutrient fluid, is subject to a continual process of decomposition and oxidation, whose rapidity varies in accordance with a number of conditions, some of which have been ascertained, while others are still unknown. Forster has recently attempted to furnish evidence of a direct kind in support of this distinction between what Voit has termed the "organic" and the "circulating" albumen of the organism (*Zeitschrift für Biologie*, xi. 4). His method consists essentially in comparing the total amount of nitrogen eliminated from the kidneys and the alimentary canal of animals supplied 'with "circulating" albumen in known quantity, with that excreted by animals supplied with albumen in an "organic" form. The first of these objects was attained by feeding the animals on azotized substances; or, in another series of experiments, by injecting solutions of ovalbumin or seralbumin into their vessels. To compass the latter object—that of introducing a known quantity of "organic" albumen into the system—transfusion of blood from an individual of the same species was resorted to. It was found that the blood so transferred did not undergo immediate decomposition; its behavior, indeed, was in all respects indentical with that of the blood originally present in the vessels of the animal subjected to experiment. On the other hand, the undigested albumen injected into the veins, or the albuminoid matters absorbed from the stomach and intestines, were found to be rapidly broken up and oxidized. This result is in perfect agreement with Voit's views on the relative stability of the "organic" albumen of the body. The urea and other waste products containing nitrogen, which are continually being cast out of the system, must therefore be derived, in great part at all events, from the non-organized albuminoids contained in the circulating fluid.

On some Phenomena produced by Irritation of the Surface of the Brain.—It has been noticed by Brown-Séquard that thermal irritation, and even mechanial injury, of the surface of the cerebral convolutions, may be followed by most of the effects which usually result from division of the cervical sympathetic, as, *e.g.*, afflux of blood, rise of temperature on the side corresponding to the injury, partial closure of the eyelids, contraction of the pupil. These effects may also be produced by laceration of the pericranium and the meninges (*Archives de Physiologie*, Octobre–Décembre, 1875). The degree of sympathetic paralysis, when this is caused by superfical cauterization of the brain, varies with the extent of surface damaged. The mechanism of the phenomenon is somewhat obscure. It is well known that irritation of the peripheral terminations of the fifth nerve is capable of giving rise to a reflex dilatation of those vessels whose calibre is governed by the cervical sympathetic. Supposing the pia matter clothing the convolutions to be supplied with trigeminal fibres, we might attribute the effect of superficial cauterization to the reflex mechanism described above. But it has been found that the phenomena are equally conspicuous when the convolutions are cauterized after removal of the pia mater. This leads Brown-Sequard to the conclusion that the ganglionic matter of the convolutions themselves is directly concerned in the production of the vaso-motor paralysis.

PROCEEDINGS OF SOCIETIES.

PHILOSOPHICAL SOCIETY OF GLASGOW.

A MEETING of the Chemical Section of this society was held recently, Mr. J. J. Coleman in the chair. Dr. E. J. Mills, "Young" Professor of Technical Chemistry, made a communication on "Fusion Point and Thermometry." He explained that in order to get exact results as to the purity of a substance under examination it was sometimes necessary to take advantage of some physical property of the body, as, for example, its fusing point: and when that point remains constant after the body had been subjected to fractional crystallization and from different solvents, absolute purity must have been obtained. The difficulties of getting correct results by using the ordinary method of taking the fusion point were very considerable, different observers with the same material often making errors amounting to 3°, 4° or even 5° C. Dr. Mills described the apparatus which he had devised for securing trustworthy results, and he subsequently mentioned how thermometers undergo changes which affect the correctness of their readings, the zero in some cases rising and in others being depressed. By being heated to 320° C. one thermometer had had its zero raised 3° C. He also indicated what a laborious duty he had undertaken in an attempt to determine the necessary corrections to make, and showed that the formula adopted by Regnault and Kopp was not to be depended on. As many as from 1500to 2000 different observations were required for each thermometer. The communication was of great scientific and practical value in connection with the determination of the fusing points of such substances as solid paraffin' butter, stearine, stearic acid, naphthaline, etc.

MUSICAL ASSOCIATION, LONDON, MARCH 6.

J. HULLAH, Esq., in the Chair.—Dr. Stone read a paper on "Standards of Pitch." The object of the paper was to examine the principal arrangements employed, and compare their trustworthiness and general efficiency. The best standards for some purposes are the French tuning-forks. The original standard was accurately determined, and the comparisons are well made. Two such forks, one fifteen years old and one new, showed scarcely appreciable differences. The forks, however, can not be much used practically on account of the feebleness and evanescence of the tone. The influence of change of temperature on strings, organ-pipes, harmonium-reeds, and orchestral instruments, was discussed and illustrated experimentally; the harmonium reeds and Hamilton's coiled strings were the only things that appeared sensibly indifferent to temperature. Organ reed-pipes appear to occupy an intermediate position. It was mentioned incidentally that steel does not answer as a material for harmonium reeds. The ordinary brass ones are good, but German silver is the best material. Mr. Bosanquet observed that General Perronet Thompson had made accurate observations on the effect of temperature on organ-pipes; he ascertained that the effect was different in large and small pipes, and invented a machine for equalizing it. Mr. Bosanquet had himself used harmonium reeds in his experiments, and considered them the best available material for practical standards; but he did not think that the problem of standards could be said to be solved until a process of reduction to the vibration number had been placed within the reach of practical men. After some remarks from Mr. Chappell and Mr. Stephens, the Chairman observed that he never heard a lecture on Acoustics without wondering that we had any music at all.

RELATIONS BETWEEN HEAT, WEIGHT, AND VAPOR TENSION OF LIQUIDS.

M. PICTET has applied the mechanical theory of heat to the study of volatile liquids, making use of the experiments of Regnault, and deduces the following simple relations between their latent heats, atomic weight and vapor tension:

1. The cohesion of all liquids is constant.
2. The differential coefficient of the Naperian logarithm of the tension divided by the temperature is constant for all liquids when referred to the same pressure and temperature.
3. The latent heat of all liquids referred to the same pressure, multiplied by the atomic weight referred to the same temperature, gives a constant product.
4. For all liquids the difference of the internal latent heats at any two temperatures, multiplied by the atomic weight is a constant number.

It thus appears that quantities at first sight wholly independent are really connected by very simple relations, which dispense with long empirical formulas based on observations more or less open to criticism.

Furthermore, admitting the law of Dulong and Petit for specific heats, we can further say that the latent heat of all liquids are multiplies of their specific heats.—*Bibl. Univ.*

[American Journal of Science and Arts, April—Abstract.]

THE GASES CONTAINED IN METEORITES.

PROF. ARTHUR W. WRIGHT, Professor of Molecular Physics and Chemistry in Yale College, has continued his investigations of this subject, and the results confirm his conclusion of last year that the spectra of the stony meteorites, like that of the Iowa meteorite of 1875, indicate a close resemblance to those of several of the comets.

Tests were made of several well-known specimens of the iron and the stony meteorites. The specimen to be examined was placed in a tube of very hard and refractory glass, which was merely softened at a red heat, and which, when filled with the meteoritic substance, could be maintained for a long time at this temperature without yielding more than so much as merely to deform the tube. In no instance was air admitted by the cracking or drawing in of the hot glass. The air was exhausted and the gas collected by means of a Sprengel pump of such perfection that it would produce a vacuum of but a fraction of a millimeter, and maintain it for days unchanged. The specimen tube having been attached to the pump, the latter was set in action and kept running until the air was thoroughly removed, as could be seen by the state of the gauge. The meteorite was then heated cautiously and the gas pumped out into the tube in which it was to be examined. Further details of the mode of procedure, where varied in the different cases, will be given in their appropriate places.

The problem of determining the exact nature and relative proportion of the gases in a meteorite is less simple than it might at first sight appear. For not only, as Grüner has shown, is metallic iron attacked by carbon di-oxide, but it also, in the presence of this gas, or other oxidizing agents, determines the reduction of carbonic oxide, and its disappearance therefore from the gaseous products. In the case of the stony meteorites the question is still more complicated, as there is always present a greater or less quantity of oxide of iron, which at an elevated temperature must exert no inconsiderable influence upon the constitution of the gaseous mixture obtained from the mass. Grüner's very careful experiments showed that pure carbonic oxide progressively reduces the oxide of iron, at a temperature of 400° C. On the other hand, it is itself reduced by metallic iron, with a deposition of pulverulent carbon, though the action is very slight at temperatures less than 400° C. The commission who reported upon his memoir, in repeating some of his experiments, found that the temperature must exceed 350° in order that this effect may be produced at all. At higher temperatures the action is very marked. More recently Sir I. Lowthian Bell, in his work containing the results of a very elaborate and admirable series of researches upon the mutual action of the two oxides of carbon in the presence of metallic iron and oxide of iron,* has, in the main, confirmed Grüner's conclusions, but has shown that the results vary, not only with the temperatures, but also with the relative proportion of these substances present. He found that pure carbonic oxide begins to reduce Fe_2O_3 at from 140° to 200° C., according to the substance used, while at a moderate red heat the oxygen is rapidly removed, with the formation of carbon di-oxide. On the other hand the latter gas was partially reduced by spongy iron at a low red heat, with the formation of carbonic oxide. We have further to consider the action of the hygroscopic moisture upon the metallic iron, as well as the mutual action of hydrogen and oxide of iron, at elevated temperatures.

It is very evident then that the composition of the gases obtained at or above the temperature of red heat can not be considered to represent accurately the true constitution of the gaseous contents of a meteorite, and especially is this true in the case of the stony ones. On the other hand we can hardly assert with confidence that the different gases are expelled in exactly their proportionate amounts at all temperatures. In fact the experiments show that the proportions of the gases vary with the temperatures of their evolution in a manner not satisfactorily explainable on the assumption that such an effect is due to chemical action alone. It is important therefore that the experiments should be conducted in such a way as to facilitate as much as possible the evolution of the gases, while at the same time they are exposed for as short time as possible to the action of high temperatures. The first of these conditions is attained in a good degree by reducing the material examined to a state of minute subdivision. The second is approximated by continuing the application of the high temperatures for the shortest time consistent with a satisfactory effect in driving off the gases sought.

In the case of the iron meteorites the material was generally prepared by boring out the solid iron with a steel drill upon a lathe, the substance being rendered as fine as possible. In some instances this was not practicable from deficiency of material, and chips produced by a planing machine were used. The stony meteorites were reduced to powder in a diamond mortar. The iron contained in them being for the most part in very minute particles, no further operation was necessary in this case. The powder from the irons, when the tube containing it was deprived of air, gave off a small quantity of gas from the mere diminution of pressure, without the application of heat, in one instance enough having been evolved to allow of its collection in a tube. A qualitative examination of it showed that hydrogen and the oxides of carbon were present, leaving no doubt that the mere pulverization of the iron was sufficient to cause it to part with a portion of its gaseous contents at ordinary temperatures, and greatly to facilitate the process at higher temperatures.

The heat was applied by means of a Bunsen burner, carried slowly back and forth beneath the tube, which was wrapped with wire gauze. For the irons the temperature was carried, in the first instance, to a point below redness, in order that the action of the iron upon the gases should be as little as possible. It was about 500° C. The gauge was watched during the heating, and as soon as it ceased to rise perceptibly, the flame was slowly withdrawn, and the gas at once pumped out. The evolution of gas at this temperature generally ceased very nearly in twenty or thirty minutes. After the gas was thoroughly removed, the iron was heated to redness with a cluster of four Bunsen burners, the heat being continued as long as any considerable amount of gas appeared to come away. This required usually but thirty or forty minutes.

Not only do the stony meteorites give off a much larger volume of gas at low temperatures, but the composition of it is in all the cases examined quite distinct from that of the gas evolved from the irons. In no case among the results obtained from the latter is the amount of carbon di-oxide greater than 20 per cent at 500°, nor than 15 per cent from the whole quantity evolved, while in every case but one the volume of carbonic oxide is considerably larger. In the chondrites, on the other hand, the percentage of the latter gas is conspicuously small, while the carbon di-oxide is more than half of the total quantity of gas obtained up to red heat, except in the case of the Iowa meteorite, and in that the percentage is not much less, especially if we reject the numbers in the last column above, for the amount obtained by a second and long-continued application of red heat. At a temperature of about 350°, it constitutes from 80 to 90 per cent of the gaseous products, in all cases, while at the heat of 100° C. it forms somewhat more than 95 per cent of the gas evolved in the only two cases examined in this respect. The hydrogen, on the other hand, progressively increases in quantity with the rise in the temperature of evolution, and in the last portions given off at red heat is generally the most important constituent. Its proportion in the total percentage would, no doubt, be considerably increased if the heat were greatly intensified, as, for instance, if carried to a point approaching whiteness, but the results obtained in such a way would be entirely unreliable, from the action of the metallic iron and the oxide of iron on the carbon compounds, or upon the hydrogen itself.

In the examination of the Parnallee, Pultusk and Weston meteorites, a small quantity of the moisture given off at a high temperature was collected in a glass tube attached to the pump and surrounded with a freezing mixture. This, when tested, gave distinct traces of chlorine for the Parnallee and Weston, but that from the Pultusk seemed to contain little or none. The latter, however, as well as the Parnallee, showed the presence of a minute quantity of sulphurous oxide, the Weston meteorite less certainly.

* "Chemical Phenomena of Iron Smelting."

[Chemical News.]

TREATMENT OF ANTHRACEN OIL.

By A. McDONALD GRAHAM, F.C.S.

THE treatment of the oil filtered from the deposited anthracen presents some difficulties, principally from the fact that the anthracen yielded on a second operation is generally so impure as to be unsalable.

Many small manufacturers prefer to sell the oil without treatment rather than be at the trouble and expense of separating the anthracen, and by others it is frequently allowed to accumulate to an inconvenient degree. I have at times observed large quantities of this oil, in the yards of some manufacturers, placed in casks, waiting either for a favorable sale or a convenient time for operating upon it.

Without pretending to have entirely solved the problem of its successful treatment, in a commercial and economic point of view, I may yet be allowed to throw out some suggestions, which may perhaps lead to a response from some of your numerous readers, and thus be the means of affording additional light on a subject of some importance to manufacturers.

At present I believe there are two methods of extracting the anthracen from the filtered oil employed by tar distillers. One of these methods consists in subjecting the oil to fractional distillation, retaining only that portion of the distillate coming over between 300° and 360° C. Some manufacturers, however, prefer to re-distil the oil in a cast-iron retort, rejecting the first portions, and continuing the operation until the residue is coked.

As to the first of these methods, namely, purification by fractional distillation, any one who has made the trial will, I think, agree with me that it is a work of some difficulty and expense, and not to be attempted if an easier method can be found.

The second mode of operating on the oil, namely, distilling to a coke, has the merit of extracting all the anthracen, and was, I believe, in general use by tar distillers when the anthracen was sold by the petroleum and bisulphide test. The quantity of real anthracen contained in the distillate of course varies according to the nature of the oil operated on; but it is usually very small, amounting on an average to about 12 per cent.

The method which I have found to give good results is to condense the oil, and allow the residue to cool, and the anthracen to crystallize out as at first. In order to do this I place, say, 1500 gallons of the filtered oil in a wrought-iron still, and distil until crystals of anthracen begin to appear in the distillate on cooling: the distillation is then stopped, and after the temperature of the remainder has become sufficiently reduced I run it out into a tank, and allow the liquid to cool, when the anthracen crystallizes out in large quantity. A second and a third condensation can be made if necessary; but I have usually found that the oil was sufficiently exhausted in one operation.

The solid portion deposited in the tank will now be found to contain at least 17 per cent of real anthracen, and will be much easier to treat either by fractional distillation or washing, being comparatively free from hydrocarbons coming over at a higher temperature than anthracen. I have found no difficulty in obtaining 36 per cent anthracen by this method, and others by care may arrive at better results.

Should washing be resorted to, it must not be overlooked that the crystals of all the substances dissolved are deposited according to their solubility in the dissolving medium, and by acting upon a knowledge of this fact the best results may be obtained.

PARAFFINS AND THEIR ALCOHOLS.

AT the Royal Institution, on Friday evening, March 3d, Dr. Odling, F.R.S., delivered a lecture on this subject. He commenced by referring to the large group of hydrocarbons generally, pointing out that chemists are now acquainted with many hundreds of compounds of hydrogen and carbon, while still there are but two compounds known of hydrogen with oxygen, and two of carbon with oxygen. There is hardly a chemist who has done any original work but has added to our knowledge of the hydrocarbons. While most of them readily enter into combination to form further compounds, there is one easily recognizable group that does not, and the members of this group, from their slight affinity for combining, are called paraffins. Hydrocarbons of this inactive chemical habit are some of them solid, some of them liquid, whether spirituous or oily, and some of them gaseous. The best known of the gaseous paraffins is marsh-gas—the inflammable gas of coal-mines, and most abundant constituent of ordinary coal-gas. Of the liquid paraffins, the most dense varieties are used as lubricating oils; the intermediate varieties are used as burning oils, and such is now the perfection of mechanical skill that their use is not attended by danger or even offensive smell. A collection of paraffin-lamps, lent by Messrs. Gardner, was displayed in the ante-room. The highest and most volatile varieties constitute benzoline, a liquid of many uses in the arts, but exceedingly dangerous for lamps. Some cannon-like explosions were produced by igniting a little benzoline on cotton-wool diffused in a jar of oxygen. The solid paraffins are largely used in the manufacture of candles. The paraffins are the most highly hydrogenized of the hydrocarbons, and hydrocarbons not belonging to the paraffin class become converted into paraffins by their direct or indirect fixation of additional hydrogen. The study of the proportion in which the relative amount of hydrogen and carbon occurs has been of inestimable value in affording a key to the solution of many difficult problems in organic chemistry. In all the paraffins—gaseous, liquid, or solid—it has been found that the number of their proportions of hydrogen exceeds by two proportions twice the number of their proportions of carbons. The different methods of obtaining these so-called synoptic formulæ were referred to in order to show that they really are expressions of well-ascertained facts. From the time this has been established, the chief interest of the paraffins to the chemist has been the study of their isomerism. For example, though the compounds carbon 1 hydrogen 4, carbon 2 hydrogen 6, and carbon 3 hydrogen 8 apply each of them, so far as is known, to a single paraffin only, the formula carbon 4 hydrogen 10 applies to two distinct compounds; the formula carbon 5 hydrogen 12 to three distinct compounds; the formula carbon 6 hydrogen 14 to five distinct compounds; the formula carbon 7 hydrogen 16 to eight distinct compounds, and so on. Thus there are two distinct gases or highly volatile liquids known, expressible by the formula carbon 4 hydrogen 10; the less volatile of them, normal butane, boils at 1° above freezing-point; the more volatile, isobutane, boils at 15° below, and further the similar derivatives obtainable from the two butanes by similar processes present corresponding differences in their properties. Thus the butyric acid obtainable from normal butane is of specific gravity 981, boils at 163°, and yields a calcium salt which crystallizes with one proportion of water, and is more soluble in cold than hot water, while the butyric acid obtainable from isobutane by exactly the same process, and having the same composition, has a specific gravity 959, boils at 154°, and yields a calcium salt crystallizing with five proportions of water less soluble than the other, but following the usual rule with regard to hot and cold water. Many other similar instances were adduced in illustration. Such facts, gradually acquired by the continued labor of many patient investigators, Prof. Odling spoke of as making known one of the most remarkable phenomena, and offering one of the most suggestive problems of modern organic chemistry. The study of the conversion of paraffins into alcohols is of great interest, and, as far as is known, there appear to be as many isomeric primary alcohols as there are isomeric paraffins. Some have primary and secondary alcohols, some primary and tertiary, some primary, secondary, and tertiary. The study of these, more than perhaps any thing else, helps to increase our knowledge of organic chemistry.

COAL-OIL *VERSUS* GAS.

IT is shown by recent experiments that the flame from an ordinary kerosene-lamp, burning a fine grade of oil, will throw a shadow of the same density at 5.3 feet from the object as a gas-flame from an ordinary 6-feet burner at 7 feet. Calculating the strength of the light, then, by the square of these distances, we find the proportion is as 49 to 28, or 7 to 4. To produce the light of 4 gas-jets, therefore, it would require 7 oil-lamps. The cost of the former, at $2.50 per thousand feet, would be about six cents per hour, while the latter, at 30 cents per gallon for oil, would be just three cents, the consumption by the seven lamps being one-tenth of a gallon per hour. Now practical experience has shown that the illuminating powers of the gas we burn in New York and Brooklyn is but a trifle greater than that of a high grade kerosene-oil, and it is undoubtedly safe to assume that the same volume of light can be obtained from seven ordinary lamps that would be given by six gas-burners of the size named. This would reduce the cost of oil to one-third that of gas. Were there no leakages of gas and no mistakes in measurement—always in favor of the companies—this might fairly represent the saving; but as it is, we find the reports from consumers everywhere show the cost of oil to be not more than one fifth of gas. In addition to this we have the fact (says the *Grocer*), which is acknowledged by every one, that the light from oil is much softer and pleasanter to the eye than that produced by burning gas. In experiments recently made at Louisville, was shown that eight star-candles were required to produce the light of one gas-burner. The cost of the former would be nearly double that of the latter; but for reading and other purposes where a near light can be used, it was shown that the cost was largely in favor of the candles, though the showing is by no means so heavily against gas as in comparison between the latter and oil.

PHOTOGRAPHIC APPLICATION OF THE RADIOMETER.

MR. CROOKES says: "To photographers the radiometer will be invaluable. As it will revolve behind the orange-colored glass used for admitting light into the so-called dark room, it is only necessary to place one of these instruments in the window to enable the operator to see whether the light entering his room is likely to injure the sensitive surfaces there exposed; thus, having ascertained by experience that his plates are fogged, or his paper injured, when the revolutions exceed, say, ten a minute, he will take care to draw down an extra blind when the revolutions approach that number."

In the case of extra sensitive films like those of Kennett's gelatine pellicle, such an aid to the estimation of the amount of light in the dark room will often be found of service; but its value in estimating camera exposures is more important still, and here in many cases it may become invaluable. Mr. Crookes on this subject says:

"Still more useful will the radiometer be in the photographic gallery. Placing an instrument near the sitter at the commencement of the day's operations, it is found that, to obtain a good negative, the lens must be uncovered, not for a particular number of seconds, but during the time required for the radiometer to make, say, twenty revolutions. For the remainder of the day, therefore, assuming his chemicals not to vary, the operator need not trouble himself about the variation of light; all he has to do is to watch the radiometer and expose for twenty revolutions, and his negatives will be of the same quality,* although at one time it may have taken five minutes, and at another not ten seconds, to perform the allotted number."

BLACK BLUE.

BOIL forty-five minutes with 2 lbs. 3 ozs. argol, 2¾ ozs. chromate of potash, and 1 oz. blue vitriol. Let cool in the liquid, and dye at a boil for thirty minutes in a fresh beck, with 5 lbs. 7 ozs. St. Domingo logwood and 2¼ ozs. sulphuric acid.—*Reimann.*

* In this brief sketch I omit reference to the occasions in which the ultra-violet rays diminish in a greater proportion than the other rays.

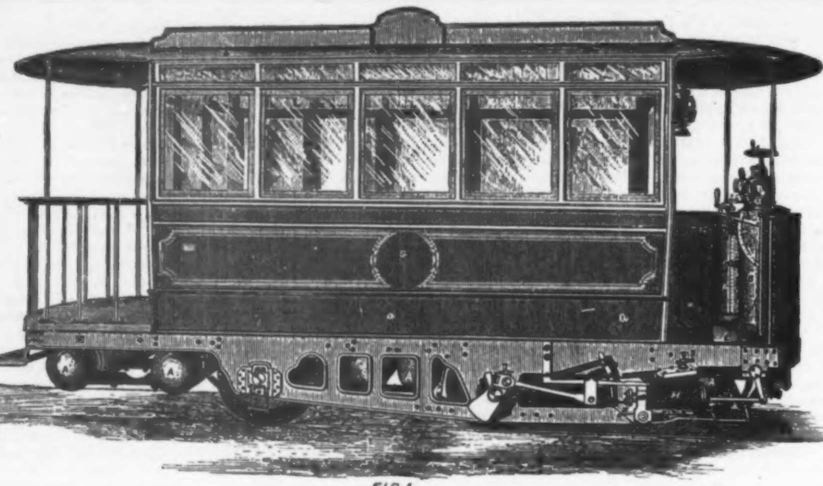
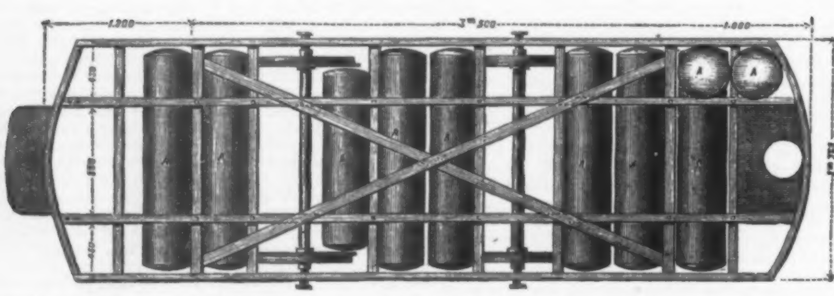


FIG. 1

FIG. 2. PLAN OF FRAMING WITH CARRIAGE REMOVED



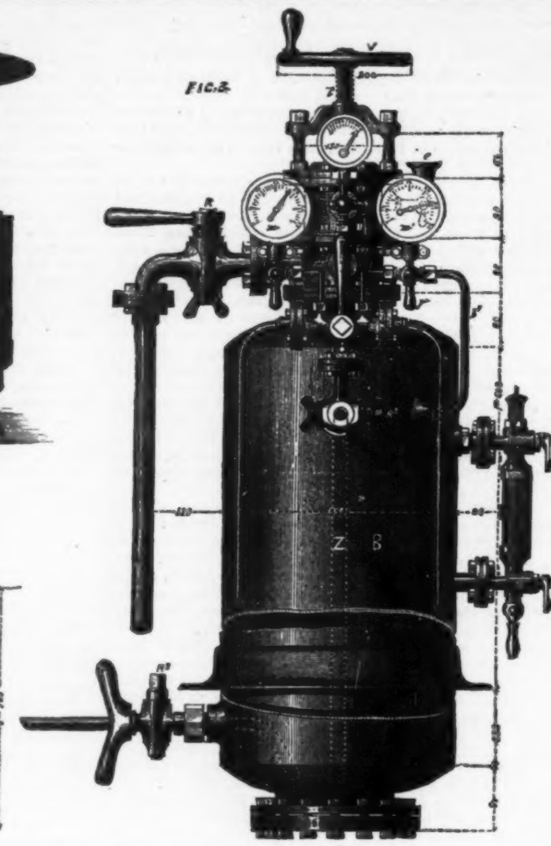


FIG. 3.

THE MEKARSKI COMPRESSED-AIR STREET RAILWAY-CAR.

MEKARSKI'S TRAM-CAR.

This tram-car, which works with compressed air, heated as used by being passed through hot water, was successfully run the first day of the present year on one of the Paris tramways—that from Courbevoie to the Barrière de l'Etoile. The mechanical portion consists of four distinct parts—the reservoirs, the heater, the regulator, and the propelling-gear. The reservoirs are cylindrical receptacles, made of plate-iron, and varying in diameter from 30 to 40 centimetres—12 in. to 16 in. They are perfectly air-tight, the joints having been welded in some cases, and riveted in others, by way of experiment. The reservoirs are connected together by copper pipes, and are divided into two series: one of a total capacity of 1500 litres—53 cubic feet—constitutes the main or working portion, while the other, of one third the capacity, constitutes the reserve. On leaving the reservoirs, the air passes through a column of hot water, by means of which it becomes saturated with steam at a high temperature. This water, injected into the heater, before starting, at a temperature of 170° to 180° C.—338° to 356° F.—gradually loses its heat on the journey, and its final temperature varies, according to circumstances, from 100° to 120° C.—212° to 248° F. For 1500 litres of air used, from 70 to 80 litres of water are generally found sufficient. In the upper portion of the heater there is a mixture of air and steam at the pressure of the reservoirs. Instead of allowing the gaseous mixture to enter the cylinders at the reservoir pressure, which is constantly varying, it is caused to pass through a special appliance called the regulator, which consists of a clack-valve, having a tendency to keep the exit-orifice closed, but which may be opened by bringing a certain force to bear upon a piston of large surface connected with it; when this force opens the valve, the result is a pressure of discharge, which acts on the piston in a contrary direction, and tends to close the valve. The pressure of discharge is then measured by the force which acts on the piston. Now as this very force is produced by compressed air, it follows that the pressure of discharge is equal to the pressure of the compressed air in the regulator. This pressure is regulated by a small plunger worked with a hand-wheel by the driver. The pressure of air and steam allowed to enter the cylinders is, therefore, regulated automatically to a given point, notwithstanding the variation of pressure in the reservoirs, while, at the same time, this pressure is variable at the will of the driver. On leaving the regulator, the gaseous mixture enters the cylinders, where it acts upon pistons connected with gear more or less like that of a locomotive.

In Fig. 1 of the engraving, G is the body of a vehicle to carry twenty passengers, and P a platform with standing-room for fourteen more. A A are the reservoirs containing air compressed to 25 atmospheres; a a, the supplementary reservoirs constituting the reserve; and f is a double pipe leading the compressed air from the reservoirs, or from the reserve, in case of need, to the distributing cock R^1. This double pipe is marked u and X in Fig. 3. B is the heater and S the regulator, shown more clearly in Fig. 3; g is a pipe leading the hot air, saturated with steam and regulated to the given pressure by means of the regulator, from the heater to the valve-chest of the cylinders. These details are shown enlarged at Fig. 3. M is the cylinder, mounted outside the frame, with slide-valve. In order not to complicate the drawing, the reversing-gear, cylinder-cocks, etc., have been omitted. L is the foot-plate for the driver; it also carries a reservoir which serves to store up air compressed by the action of gravity while descending long gradients.

In Fig. 3, B is the heater filled with water at 170° C.—338° Fahr.—to about three parts of its height; N is the water-gauge; and R^1, the cock by which the compressed air is led to the heater from the reservoirs or from the reserve; while X and u are pipes for leading the air to the cock R^1 from the reservoirs and from the reserve respectively. Z is a pipe leading the compressed air from the reservoirs or the reserve, according to the position of R^1, to the lower portion of the heater; R^2 is a cock by which the compressed air is introduced before starting; and R^3, that for the injection of the hot water. The reservoir pressure-gauge is shown at m, connected to the reservoirs by the pipes l'' and x; and m^1 is another pressure-gauge, which is connected by the pipes l and u to the reserve, or by the pipe l^1 to the heater, according to the position of the cock y. S is the pressure-regulator, having a diaphragm as shown, and connected with a chamber C, containing air in tension. E is the distributing chamber; t, the rod of the plunger, which permits of varying at will the tension of the air in the chamber C, and, consequently, the pressure of the air admitted into the cylinders; and V, the hand-wheel for actuating the above. R is the cock for admitting the air into the cylinders; and g, the pipe leading the hot air, saturated with steam and at a given pressure, from the heater to the valve-chest of the cylinders.

It will be seen that the air passes either from the reservoirs through the pipe X, or from the reserve through the pipe u, to the distributing-cock R^1; thence through the pipe Z to the heater B; thence to the distributing-chamber E, and through the cock R to the valve-chest by the pipe g.

The frame of the tram-car is carried by two axles, rather near together for going round curves easily, and to this frame are attached the cylindrical reservoirs; the arrangement of the body of the vehicle is that of the Northern Tramway Company of Paris.

This self-propelling tram-car, designed by M. Mékarski, is, as far as the mechanical portion is concerned, quite different from any other motor. On account of the use of air saturated with steam, a high degree of expansion permits of a long run being made with a small quantity of air, the expenditure of which, at a pressure of 25 atmospheres on an ordinary tramway, was less than 200 litres per kilometre—about 11 cubic feet a mile. The working is noiseless. Certainly on gradients of 1 in 50 there was a slight noise due to the exhaust; but it must be borne in mind that the trial engine was not constructed for so steep a gradient. The steam does not exhaust, because its office is to become condensed in the cylinders as completely as possible for the purpose of restoring to the air all its latent heat. The great feature of this tram-car is the ease with which it may be handled, the operations of reversing, slackening, or increasing speed, and stopping suddenly, being performed with far greater ease than with a pair of horses.

At one end of the tramway must be erected some powerful expansive condensing-engines, working pumps for compressing the air to a pressure of 25 to 30 atmospheres, and forcing it into the tram-cars while they are standing, the excess being stored up in fixed reservoirs. Each tram-car, after having completed its double journey, receives its charge of compressed air, while the heat lost during the run by the water in the heater is restored by steam led through a flexible hose. The same system may be applied to engines for drawing ordinary cars after them; but the problem has been practically solved of running a self-acting tram-car along street tramways under favorable conditions of management and cost of working.

In conclusion, we have to acknowledge our obligation to our contemporary, *Les Annales Industrielles*, for the above facts, and also for the drawing from which our illustrations have been prepared.—*The Engineer.*

REFRIGERATING RAILWAY-CAR.

REFRIGERATING RAILWAY-CAR.

By J. E. Winants, Wilmington, N. C.

When air is compressed to a density of two or more atmospheres, there is evolved heat in proportion to density, which is to be absorbed by a suitable device, and the cooled compressed air, upon being released, expands and again absorbs heat and produces a degree of cold in proportion to its former density.

The air-pump A being set in motion by operation of the band on the shaft D, through the crank K, the air is forced into the receiver B to the pressure of two or more atmospheres. At the same time motion from the shaft D is imparted, through a band, to the blower or fan C, supplying air to the outside surface, and through the pipes E of the receiver or drum B, and within the wooden casing F, in the direction of the arrows, as shown in the drawing. In this manner, by the constant passage of a current of air through the receiver, the heat contained in the compressed air is taken up from the receiver and discharged into the atmosphere, while the cooled compressed air is delivered into and expands within that portion of the car that is to be refrigerated.

PLAN FOR CHANNEL RAILWAY.

At a recent meeting of the Society of Engineers, London, a paper was read by Mr. Perry F. Nursey, C.E., on the Channel Railway proposed by Mr. P. J. Bishop, but the details of which were worked out by the author himself. The system consists of two distinct tubes of cast-iron, each carrying a line of rails laid on the bed of the Channel between Dover and Cape Grisnez, a distance of 21½ miles, at an estimated cost of one million sterling per mile. The tube, which is elliptical in section, would be 4 inches thick, cast in 5 feet lengths, bolted together by internal flanges, lined inside with brickwork laid in cement, and that cased again with ⅜ inch boiler-plate; the outer dimensions 17 feet 8 inches diameter of the major axis, and 14 feet 8 inches the minor axis, the inner diameters being 15 feet and 12 feet respectively. The tube would be sunk in 25 feet lengths, an ingenious water-tight bulkhead being fixed at each end, with a central guide to bring them in juxtaposition for bolting when they are sunk. The bulkheads are removable from the inside, and would be sent on shore in a trolly as the tube progressed, to be used for a fresh section. The operation of sinking would be carried on from a floating pontoon 400 feet long by 100 feet wide, with a central opening 100 feet by 25 feet, surrounded by staging for lowering each section. Plans were shown of the details of this novel scheme, for which the author claimed that it was perfectly practicable, and that it could be completed for the estimate in five years, or, if necessary, in three years.

MINING-MACHINERY.

The following machinery is employed in the colony of Victoria, Australia, in alluvial mining: 336 steam-engines, of 8914 horse-power; 258 steam puddling-machines, 6 buddles, 1050 horse puddling-machines, 218 whims, 208 whips or pulleys, 15,283 sluice-toms and sluice-boxes, 30 hydraulic boxes, 596 pumps, 217 water-wheels, 154 quicksilver and compound cradles, 497 stamp-heads for crushing cement, 16 boring-machines. In quartz-mining there were employed: 774 steam-engines, of 15,543 horse-power; 73 crushing-machines, driven by other than steam-power; 6836 stamp-heads, 46

buddles, 7 winding, washing, or pumping machines, driven by water-power, 596 whims, 4 boring-machines, used in blasting. The approximate value of the mining-plant was £2,053,207. The number of square miles of auriferous ground actually worked upon was 1093.

LESSONS IN MECHANICAL DRAWING.

By PROF. MACCORD, Stevens Institute.

(Continued from page 254.)

No. IX.

IT will be found that in order to acquire full control over the compasses, so that lines may be drawn precisely as they are intended to be, in either pencil or ink, considerable practice will be required. It is not enough that we shall be able to draw a circle with a full, clear, sharp line, or to dot one

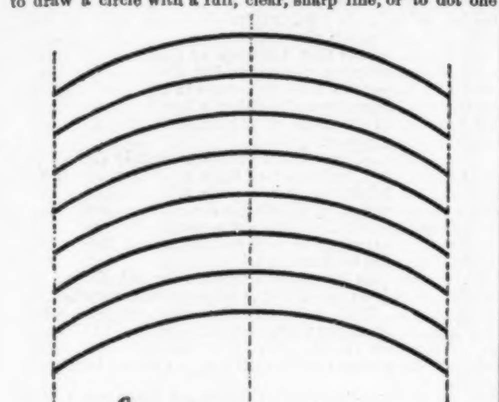


Fig. 92.

neatly and regularly. These things are necessary, of course, and we must try again and again, to the thousandth time if need be, until they can be done with confidence, whatever the thickness of the lines. And it is enough for us to say this: It is not necessary to give any figure in order to show what a complete circle should be like. But then it is required to draw *arcs* only, which, like the straight lines, should terminate as smoothly as they are drawn—that is, at least the draughtsman should be able to make them so at pleasure. Sometimes a ragged ending is desirable, as when, for instance, a portion of a wheel is shown, a part being supposed to be broken off;

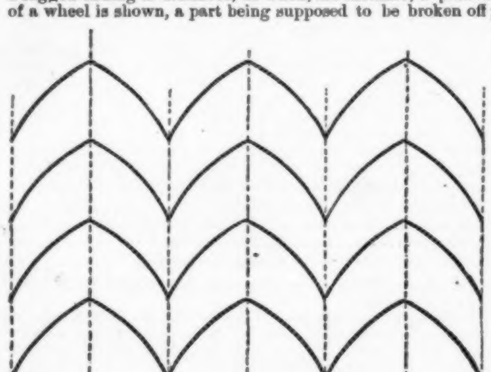
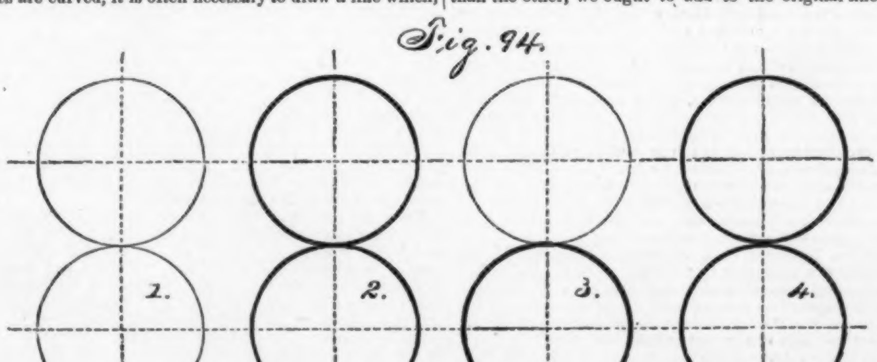


Fig. 93.

but at others this effect will be just what we wish to avoid. Again, we have arcs intersecting each other, or intersecting right lines, at various angles, in which case the faults to be avoided are of the same kind as those in the intersection of right lines shown in Fig. 32, and to avoid them will require as much care and more practice. Also, arcs or circles are to be drawn tangent to each other, or tangent to right lines or other curves than circles, and this when one or both may be dotted, as well as when both lines are full. And yet again it will be found that in putting in shadow-lines on work where the outlines are curved, it is often necessary to draw a line which,

Fig. 94.



instead of being of uniform thickness, gradually tapers, which requires a new manipulation of the instrument, and usually is found more difficult by novices than any other operation performed with it. We do not propose now to go into an explanation of this last, but we give a series of exercises in the other particulars above enumerated. Fig. 92 consists merely of a series of arcs, terminated in the cut by dotted lines, the centres being upon the middle line, which is also dotted. These arcs are not concentric, but all have the same radius, and are to be drawn repeatedly, with various radii, and of different lengths, as well as with different breadths, the lines which are here drawn dotted being merely pencilled as lightly as possible, and subsequently erased. Fig. 94 is a series of intersecting arcs, the centres being as before on the same lines, and the arcs all of the same radius; the difficulty in this exercise lies in terminating the arcs so that the intersections shall be clear and sharp, with acute looking like knife-edges. The same remarks in reference to the dotted lines apply here too; and the beginner is advised to vary the

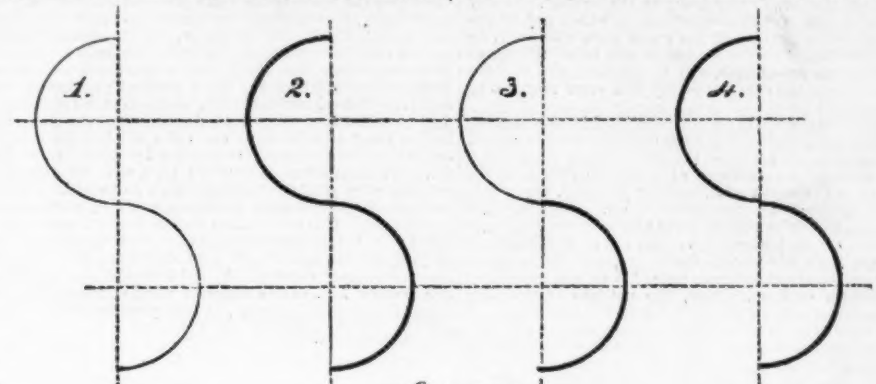
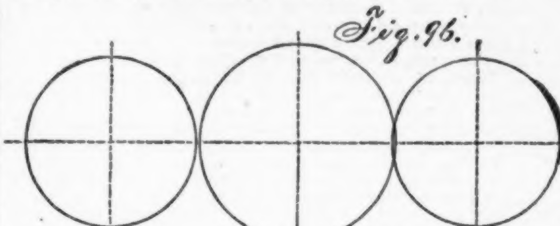


Fig. 95.

radii, and also the relative positions of the centres, so as to make the curvilinear angles included between the arcs more or less acute, it being understood that these figures are given not merely to be *copied*, but as illustrations of the *kind* of exercises recommended for practice; and that the more perfect control of the instruments is acquired by the repetition of these, the less liability will there be of spoiling otherwise good work when similar cases are met with, as they continually are, in regular drawings. In Fig. 94 we have circles

Fig. 96.



which are tangent to each other. The first pair are drawn in fine lines, the second in heavy ones, and in the third one is fine and one heavy. Now, it is to be particularly noted that in the second the two thick lines merge into each other, the line being no heavier where they meet than if there were but one circle. A very common error is illustrated in the fourth pair of this group, in which the *lines* touch each other, it is true, but if they be looked at from a considerable distance—so great that the line appears fine—it will be found that the eye will not be satisfied: the *circles* will not appear tangent,

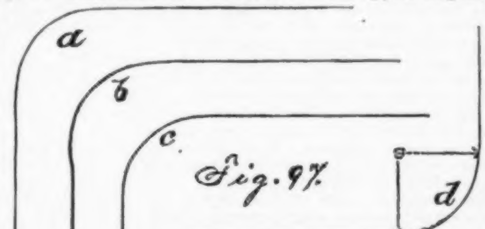


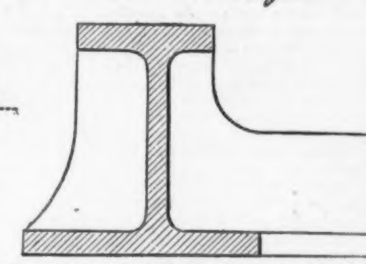
Fig. 97.

while the pair No. 2 will. The reason of this is that a *line* really has no thickness; we represent one by a mark which has, for the simple reason that we can not see it unless it be of some breadth. "Twice naught is naught," consequently *two* lines have no thickness of their own, and if they coincide, as they do where the circles touch, they should be represented by a mark no broader than that used to indicate one of them. If, then, we choose to make one of the circumferences heavier than the other, we ought to add to the original fine line as much on the outside as on the inside, which results in the appearance shown in No. 3 of the group, the thin line passing through the centre of the thickness of the heavy one at the point of tangency.

The truth of all this will be made more striking by comparing the four lines in Fig. 95—which are identical with the preceding in construction, only that the opposite halves of the two circles in each group are omitted, leaving only the semicircles tangent. The effect obviously should be that of a sinuous line, which, however, should, when the two curves of which it is composed are of the same thickness, appear perfectly smooth; and, as obviously, this effect is produced in Nos. 1 and 2, while in No. 4 it is conspicuous by its absence. Whether the circles are complete or only arcs are tangent, special pains must be taken to make them truly so, which requires great care, particularly in inking in, with respect not only to the location of the centre but the adjustment of the radius: the least error in either will lead to such results as are shown in Fig. 96, which need only be seen to be appreciated—and they *will* be seen, the reader may be assured, if they exist, as nothing is more certain to attract attention than a circle which is close to another or to any line; the very fact of their close neighborhood leads to the question whether they are meant to touch each other or not.

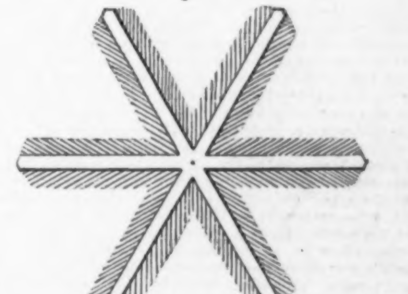
In drawing straight lines tangent to circles, either fine or heavy, the same precautions are to be observed. Combinations of this kind are continually met with, especially in the

Fig. 98.



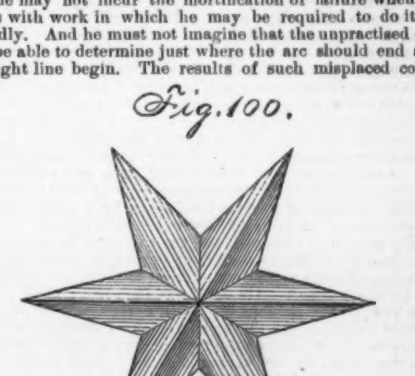
drawing of machinery, the most common being that in which an arc only of the circle joins the straight line, as in Fig. 97, *a*. The effect should be as there shown—that is, the whole line should appear as if drawn by one continuous movement of the pen, the junction being so smooth and perfect that it can not be found. We shall have, when treating of mechanical applications hereafter, frequent occasion to speak with emphasis in regard to this; for the present,

Fig. 99.



the student will do well to practice the drawing of this simple figure over and over, until he becomes perfect in it, so that he may not incur the mortification of failure when he meets with work in which he may be required to do it repeatedly. And he must not imagine that the unpractised eye will be able to determine just where the arc should end and the right line begin. The results of such misplaced confi-

Fig. 100.



dence, and of carelessness in general, are shown at *b* and *c* of the same figure. We stated above that when the direction of the right line is known, the eye can judge accurately of the *fact* of tangency; but it can not determine the *point* of tangency with any degree of precision. Until, therefore, the training has been long and careful, it will be necessary to find this point, as shown at *d*, by drawing through the centre of the circle a perpendicular to the tangent; in many cases, when

the radius is of importance, we indicate it and the extent of the circular arc by dotted lines as shown, the arrow-heads fixing the points of tangency, and the little ring calling attention to the location of the centre.

In inking in, the general rule should be observed *to draw the curves first, and the straight lines afterward*, because the arc is determined by both centre and radius; the least error in either affects the accuracy of the curve, and if the right line be first inked, the former may not join it smoothly. It may be said that in that case there is an error, which will be the same, so far as the location of the curve goes, whether it be drawn first or last. Very true; but it may be so trifling as not to necessitate arc-erasure, and by drawing the straight line so as to meet the curve smoothly this error may not be noticeable.

Now we do not wish to be misunderstood in this matter, and therefore we introduce Fig. 98 to make our meaning clear. It shows a section of a part of the bed-plate or frame of a piece of machinery, consisting of a bottom flange, a top flange, and an upright web, uniting the two, the whole being strengthened by transverse webs. The upright web does not, it will be noticed, form sharp square corners at its junction with the horizontal flanges, but these corners are rounded out with what are technically called fillets, represented by quadrants of little circles which should be tangent to the straight outlines. Also, the outlines of the webs consist partly of circular arcs, tangent to right lines. It needs no argument to show that an inaccuracy in the location of such circles as these, if no greater than the thickness of a line, could not affect the utility of the frame-work in any appreciable degree; and it would be the height of folly to erase and correct the lines should such an error by any mischance occur in inking them in. But it would also be absurd, should the circles be in a minute degree out of place, to draw the right lines absolutely *in* place, and thus mar the appearance of a drawing which would at least be just as correct if they were drawn to meet the curves smoothly.

We are not, it will be seen, inculcating the idea that the draughtsman is excusable for slovenliness or carelessness, and in such cases need take no pains to draw these things accurately; but since accidents will sometimes occur in spite of all care, we do say that it is not always necessary or wise to make their effects conspicuous, when if concealed they are unimportant.

It is not by any means to be supposed that the practice with the triangles and with the right-line pen is to be interrupted, because we have made mention of the compasses. We have not yet exhausted that branch of the subject, and we add here one or two examples which will introduce a new feature into the manipulation of the pen, and give a hint, by following which the diligent student may keep his leisure moments occupied in a way which will be of advantage to him when he eventually comes to execute finished drawings. Fig. 99 is a snow-flake, consisting of three narrow bars, forming merely a six-rayed star. But these are bounded, externally, not by a smooth, hard line, but by a feathery envelope of needle-like crystals or rays. In order to give these little rays, each of which is represented by a single line, the pointed termination which they should have in order to produce the best effect, the following method should be observed: Draw in pencil, as finely and lightly as possible, two lines parallel to the sides of each radial arm of the star. After the outlines of the arms themselves are drawn in ink, set the pen to its finest, and begin the "feathering" by drawing each feather *outwardly*—that is, *from* the side of the arm; begin with a moderate pressure on the pen, and diminish it as it moves outward, in such a way that although it shall be lifted off the paper at the instant it reaches the pencilled boundary, it shall be still in motion. This will require some little patience and time in order to acquire the precise touch; but the effect can not be produced in any other way by the pen alone.

In Fig. 100 we have a six-pointed star; it is not quite like the ones previously shown, as it will be noticed that the sides of the alternate arms do not coincide when prolonged. But it can readily be laid out, either with or without the compasses; and we leave the mode of construction to the ingenuity of the reader, as it does not involve any principles which we have not pointed out already. Having drawn it in outline, the next thing is to shade it; which, it will be noticed, introduces a new element. The specimens of line shading previously given have been merely representations of plane surfaces parallel to the paper, which were shaded so as to produce that effect by ruling them with parallel lines, very fine, uniform, and uniformly spaced, so that at a little distance the paper looked as if covered with a *flat* or uniform tint with a brush. Here, however, the surfaces do not appear to be parallel to the paper; the long central ridge of each arm of the star seems to be formed by the intersection of two *inclined* planes. This effect is produced, as will be seen by careful study of the figure, by making one edge darker than the other. The lines are a little heavier, as well as closer together, at the dark edge; the thickness of the lines diminishes, and the "daylight," or white space between two lines, increases as we progress toward the other edge. It is out of place here to discuss the reasons for either this or the distribution of the darker and lighter surfaces, but the student may advantageously begin now to practice in producing the effect, whatever the reason. The operation is one of considerable nicety; it requires much training of both hand and eye to enable one to shade a surface in this way so that it shall appear perfectly *plane*; and in order to do it to the best advantage, the shading should always be commenced at the darkest side, and never at the lightest; the pen being carefully tried on a scrap of paper before touching a new surface of a drawing, no matter how much practice may have been had; and the thickness of the line is changed by a slight turn of the set-screw of the pen whenever it is seen to need it. It is to be particularly observed, too, that in order to produce the effect of a plane surface sloping at any angle, the *graduation* of the tone, be the same dark or light, is in all cases uniform; that is, if it have a *certain* depth on the darker edge, it will grow lighter at a uniform rate as it approaches the other, at the middle (measured in the widest part) being of a depth exactly half-way between the two extremes. In order to produce the effect of a *bright* surface when thus shaded, it is necessary that the last of the lines on the lighter side should be exceedingly fine—and it will be found that the pressure exerted on the pen materially affects this. We may reason on it as much as we please, and say that as the pen is made of fixed parallel blades the pressure can not alter the breadth of the line, but the trouble is that it *does* alter it, reason or no reason; hence this kind of practice will be found a great aid in convincing those who think otherwise, and in forming a habit of using the least possible pressure.

All the spacing, both of the feathers in Fig. 99 and of the shading in this, should be, and in fact must be, done by the eye alone. We do not by this pretend to intimate that in the case particularly of the former example it would be impossible to step off divisions by means of the small spacing dividers, or to mark them off with a pencil from the edge of a well-divided scale. But after the points are marked, the lines have yet to be drawn, and in setting the pen against the edge of the triangle, it will be found that the proper adjustment, so that the lines shall pass precisely through the points, and the spacing look uniform, involves just as much of a tax on the eye, and just as great a chance of error, as it would to determine the space at the same time without marking them beforehand,, consequently the latter is so much labor wasted and time lost. It will, of course, be understood that this applies only to work of this kind on the scale shown; if it be so very large that the proper spaces are several times as great, it would be better to mark them off; still even then it could not be done in the shading of the inclined surfaces. It may be added that when the latter are small the lines should be fine; and that in such cases the thicker ones may be brought up to the requisite breadth by simply running the pen over them a second or third time, without altering its set, but very slightly inclining it so as to add to the line either on the side nearest the triangle or on the other as may be required. This also is often necessary in order to destroy a part of the "daylight" between two lines, which by an error in judging the space have been drawn too far apart to suit the conditions of the case. It will be found very useful practice to draw Fig. 100 of different sizes, and to shade it with lines of various thicknesses, in both pencil and ink.

TUNGSTEN AND IRON.

By Richard Akerman, of the Stockholm School of Mines.

Metallic tungsten is so hard that it scratches glass easily, and so slightly fusible that it can not be melted in an ordinary furnace. On the other hand, it may be mixed with iron by fusion in all proportions, and the larger the quantity of tungsten, the harder and more difficult to melt is the compound. Like carbon, it appears to diminish the ductility of iron both when hot and cold, but especially when cold. It is then possible, by melting together tungsten and iron, to obtain a steel much harder than one with carbon alone, without the danger of incurring at the same time an excessive fragility when cold, or difficulties of working when hot. For uses which require a special degree of hardness, a steel rich in tungsten, called "special steel," is frequently employed. Thus a fine Sheffield steel for lathe tools, according to an analysis made by Baron Barnekow in the laboratory of the Stockholm School of Mines, contained 9.3 per cent of tungsten and 0.7 per cent of silicium, with only 0.6 per cent of carbon. This steel, which is used without being tempered for turning cylinders cast of hard iron, is of sufficient hardness to scratch glass, and yet it is not fragile, for great difficulty is experienced in breaking a $\frac{3}{4}$-inch square bar. Prof. Heeren has also found in a special steel of Mushet's 8.3 per cent of tungsten and 1.73 per cent of manganese; this steel seems by its properties to be analogous to that mentioned above. In another special steel from Howell, Sheffield, 2.863 per cent of tungsten and 1.15 per cent of carbon were found.

The hardness communicated by tungsten to iron is not increased by tempering. Steel rich in tungsten can not be hardened without breaking. It can only be worked cold by grinding, on account of its excessive hardness; by working hot with great care, the desired form may be given to it, but steel very rich in tungsten must be managed with great care to prevent its cracking, and it must be treated several times in succession before the desired form is attained by hammering. After the form is obtained by hammering hot, the steel should be hammered with quick, light blows, nearly cold, before it is allowed to cool gradually.

Tungsten is added for obtaining not only a steel of great hardness, but one of moderate hardness combined with a great softness and high ductile capacity. Thus a steel which would seem to be suitable for the tubes of cast-iron cannons gave on analysis by Tamm: Carbon, 0.52 per cent; silicium, 0.04 per cent; tungsten, 0.3 per cent; phosphorus, 0.04 per cent; sulphur, 0.005 per cent. Tested by Styffe, it showed a strength of $77\frac{1}{2}$ tons per square inch, with a ratio of the section of rupture to the original section represented by 0.54. The mean lengthening after rupture was 13 per cent, without taking into account the striction, or reduction of area due to tension, produced by the rupture, and which extended itself over about three quarters of an inch. Wolfram, the principal ore of tungsten, is a tungstate of iron and of protoxide of manganese. It may be reduced with a strong heat by being mixed with charcoal, but a very great heat will be required to melt the product, on account of the proportion of tungsten which it contains. On the other hand, this alloy becomes fusible by adding oxide of iron.

In order to produce tungsten steel, it is necessary in the first place to rid the wolfram of the impurities which it contains. According to Jacob, it must in the first place be roasted, then treated by diluted acid, and finally washed with water; in this manner, the sulphur and the arsenic are eliminated. After being dried, the residuum is raised to a strong heat in crucibles lined with damp charcoal, the tungstic acid is reduced to the metallic state, and a compound is formed containing iron and manganese. The product thus obtained is of a dark color and great density; from 5 to 25 per cent is added to the steel according to the proportion of tungsten desired. Another method patented by Mr. Mushet for obtaining tungsten steel, consists in mixing wolfram finely pulverized with an equal weight of melted pitch; the mixture is then run out on a dry stone slab, and added in certain proportions to cast-steel contained in crucibles.

To produce Bessemer steel containing tungsten, M. Le Guen, when the operation is finished, adds to the molten metal some pig containing tungsten also in a liquid state. This pig is prepared by passing into the cupola ordinary pig iron in pieces the size of the fist, conglomerated of 90 per cent of wolfram and 10 per cent of lime with tar.

A metal containing tungsten may also be obtained by melting ordinary pig in a mixture of wolfram and powdered charcoal. According to M. Le Guen, the tungsten increases the hardness of the metal, and up to a certain point its tenacity also. If, on the other hand, the proportion of tungsten becomes rather high, the strength diminishes.

Bernoulli has produced tungsten steel by melting together in a crucible tungstic acid or wolfram with cast-iron turnings or filings; but it is asserted that tungsten steel can only be obtained by this method, if the cast-iron is grey and not too rich in combined carbon, for the tungstic acid could not burn the combined carbon, but only that which was in the state of graphite and mixed mechanically in the iron. Besides, in order to obtain the desired result, the cast-iron should not be in pieces, but finely pulverized and intimately mixed with the tungstic acid or the wolfram.

[Academy.]

MICROSCOPICAL NOTES.

On a former occasion we could only allude to the remarkable address delivered by Mr. Sorby before the Royal Microscopical Society. We now proceed to notice a few of the more important points, referring the reader for further information to the *Monthly Microscopical Journal* for March, in which it is published *in extenso*.

Mr. Sorby arranges his subject under three heads: the limit of the powers of the microscope; the size of the ultimate molecules of organic and inorganic matter; and the conclusions to be drawn from the general facts. Dr. Pigott found that the smallest visible angle he could appreciate was that of a hole $1\frac{1}{4}$ in. diameter, at a distance of 1100 yards, corresponding to about 6″ of an arc. Some persons have affirmed the smallest visible angle to be 1″, which would give a microscope magnifying 1000 times a power of exhibiting an object $= \frac{1}{500000}$ of an inch. Dr. Pigott places the limit of visibility of objects under the microscope at $\frac{1}{120000}$ to $\frac{1}{500000}$. Helmholtz maintains that visibility of small objects is not merely dependent upon their size, but also upon the sensitiveness of the eye to faint differences in light, and that on this account fine gratings like Nobert's lines, or diatom markings, are best for determining the ultimate limit of the microscope's defining power.

"The smallest distance that can be accurately defined depends upon the interference of light passing through the centres of the bright spaces, and when this interference is of such a character that bright fringes are produced at the same intervals as the dark lines, and are superimposed upon them, the lines can no longer be seen and the normal limit of perfect definition has been reached."

Mr. Sorby gives Helmholtz's formula for calculating the visibility of objects when lights of particular wave-lengths are employed. With a theoretically perfect microscope, and a dry lens, the smallest visible object would not be less than $\frac{1}{80000}$ of an inch in red light, but if the lower end of the spectrum alone was used lines of $\frac{1}{110000}$ of an inch apart could be seen.

After publishing his address, Mr. Sorby found that he had made an oversight in omitting the factor expressing the specific gravity of the vapor of water in calculating the probable number of molecules in a thousandth of an inch cube, but physicists vary so much in their estimates that, with some leaning towards those of Clerk Maxwell, the number he has given may not be far from the mark. He considers the number of molecules in that quantity of water as 3,972,000,000,000,000. In such a complex substance as albumen, if taken in the condition of horn, the number of molecules in a cubic $\frac{1}{1000}$ of an inch is reckoned at 71,000,000,000,000. Thus in the length $\frac{1}{80000}$ of an inch, the smallest object that we can rely upon seeing, there might be about 2,000 molecules of water, or 520 of albumen, and to see them would require from 500 to 2000 times the power we now possess. Such power, Mr. Sorby observes, "would be of no use unless the waves of light were some $\frac{1}{1000}$ part of the length they are, and our eyes and instruments correspondingly perfect. . . . We are, as matters now stand, about as far from a knowledge (by vision) of the ultimate structure of organic bodies, as we should be of the contents of a newspaper seen with the naked eye at a distance of a third of a mile."

Mr. Sorby then treats the question of Darwin's Pangenesis with reference to the number of molecules in the germinal matter of eggs, and the spermatic matter supplied by the male. In a $\frac{1}{1000}$ of an inch cube he reckons——

Albumen..............	18,000,000,000,000	molecules
Water..............	992,000,000,000,000	"
	1,010,000,000,000,000	

or in a sphere of the same diameter, 530,000,000,000,000 of the two components.

According to the Pangenesis theory, the remarkable facts of inheritance, extending even to the reproduction of unimportant peculiarities of parts or organs, and the occasional outbreak of ancestral characters that have been dormant through several generations, are accounted for by the supposition that each part of an organism contributes its constituent and effective molecules to the germ and sperm particles. These Darwinian gemmules must be extremely minute as well as extremely numerous. Mr. Sorby assumes that they may be spheres, each containing a million molecules, and that one thousand of them would make a mass just within the reach of microscopic vision.

Taking a single mammalian spermatozoon, having a mean diameter of $\frac{1}{8000}$ of an inch, "it might contain two and a half millions of such gemmules. If these were lost, destroyed, or fully developed at the rate of one in each second, this number would be exhausted in about a month, but since a number of spermatozoa appears to be necessary to produce perfect fertilization, it is quite easy to understand that the number of gemmules introduced into the ovum may be so great that the influence of the male parent may be very marked, even after having been, as regards particular character, apparently dormant for many years."

The germinal vesicle of a mammalian ovum, being about $\frac{1}{1000}$ of an inch mean diameter, might contain five hundred millions of gemmules, which, if used up at the rate of one per second, would last more than seventeen years. Even with these numbers Mr. Sorby considers the theory would fail to account for the appearance of dormant characters in the second or following generations, unless the granules were gifted with the power of "reproducing others more or less closely resembling themselves, and of collecting together more especially in the sexual elements."

Thus the molecular constitution of matter is not inconsistent with the arguments of this startling theory, in aid of which Mr. Sorby's investigations may claim the highest degree of importance, for, as he says, "if there had been good evidence to prove that the ultimate atoms of matter are very much larger than is indicated by the properties of gases, the gemmule theory could hardly have been maintained, since the possible number of gemmules that could have been present in the germinal vesicle or spermatozoa would not have been adequate to explain the various facts of inheritance."

We notice that Mr. Stiles, writing in the *Monthly Microscopical Journal*, recommends for staining wood sections one grain of the finest cake or crystal magenta dissolved in two ounces of spirit, or half a grain of pure aniline soluble blue in one dram of distilled water, to which he adds ten minims of dilute nitric acid, and enough spirit to make the quantity up to two ounces. After staining he washes with spirit, soaks for an hour in cajeput oil, and afterwards in turpentine, finally mounting in balsam or dammar. The cellular tissue takes the blue more readily than the red, "the vascular tissue to a great extent retaining the red when subsequently treated for a short time with blue."

CITRIC ACID.

By Robert Warington.

Citric acid has been known to us as a distinct acid since 1784, when it was separated from lemon juice by Scheele. Citric acid occurs in many vegetable juices; it is obtained for the purpose of the arts from the fruit of three species of the genus *citrus*, namely, the lemon, bergamot, and lime. Lemon juice (from which about three-fourths of English citric acid is made) is exported as concentrated juice from Sicily. Concentrated bergamot juice is prepared on the Calabrian coast of South Italy, and is exported thence or from Messina. Concentrated lime juice is exported in small quantities from Montserrat and Dominica in the West Indies. The total quantity of lemon and bergamot juice shipped to England during 1875 was certainly not under 1800 pipes, and perhaps reached 2000; of this about 500 pipes were bergamot. Besides the juice used for the citric acid manufacture, a rather considerable quantity is exported to Liverpool and Glasgow for the use of the calico printers. The quantity of concentrated lime juice used in the citric-acid manufacture in 1875 was about 100 pipes.

The concentrated lemon juice of Sicily is obtained from windfalls, and from more or less damaged fruits, which could not be shipped as lemons; from such fruit essence and juice are prepared. The lemons, after peeling, are packed in flag baskets, having a very small mouth; these baskets are placed one on the other, so that the mouth of each is closed by the basket above it; the whole is then pressed in a screw press. On an average, 13,000 lemons are required to yield one pipe (108 gallons) of raw juice. The concentration is effected in a copper vessel over an open fire; the juice is boiled down till it marks, when cold, 60° on the citrometer. On the citrometer 1° is equal to .004 specific gravity, 60° therefore equal 1.24 specific gravity. The hot concentrated juice is strained through canvas into pipes, and is then ready for exportation.

The process of preparing citric acid from juice is exactly the same as that employed by Scheele in his original investigation; the improvements since his time have been chiefly mechanical. The concentrated juice, diluted with water, is first neutralized by whiting, the operation being aided by heat. The resulting citrate of calcium has a different mechanical character, whether the juice is added to the whiting, or the whiting to the juice; in the former case precipitation is immediate, and the precipitate is finely divided; in the second case precipitation is more gradual, and the citrate heavy and more crystalline.

Concentrated lemon juice is never perfectly neutralized by chalk, however long the boiling may be continued; litmus is thus of no use in determining the point of saturation; this is, however, readily ascertained by testing a portion of the mixture for acid by a further addition of whiting, and for excess of whiting by a few drops of acid, effervescence in either case being the indication sought. The amount of unneutralized acid on the large scale is 1-2½ per cent of the acidity of the juice. It has been proposed to complete the neutralization with slaked lime. This would no doubt precipitate a further quantity of citric acid; but it is found that perfect neutralization occasions the precipitation of much coloring matter and impurity; the manufacturer prefers, therefore, to leave the liquor in its natural feeble acidity. Pure citric acid is readily and completely neutralized by chalk; malic and aconitic acid are not. Citric acid if mixed with phosphoric acid, and especially with phosphate of iron, is also not neutralized by boiling with chalk. As phosphoric acid and iron are certainly present, and probably also malic and aconitic acid, the explanation of the partial neutralization of juice is not difficult.

A considerable improvement in the manufacture both of citric and tartaric acid is the introduction of vacuum filters; by their means precipitates can be washed with a far smaller quantity of water than formerly; this is specially important in the case of citrate of calcium, owing to its partial solubility in water. Crystalline citrate of calcium prepared in the laboratory, I find to have a mean solubility of 1 in 1180 at 14° C., and of 1 in 1730 at 90-100° C. The citrate being, as is well known, less soluble in hot than in cold water. A specimen of amorphous citrate, prepared by adding juice to whiting, had a higher solubility, namely, 1 in 707 at 18° C., and 1 in 1123 at 100° C. There is no doubt that a rather considerable loss occurs in washing citrate, and in warm weather there is also risk of decomposition if this operation is not quickly conducted.

The citrate of calcium, after washing, is mixed with water, and is then ready for decomposition with sulphuric acid, by which sulphate of calcium (gypsum) and free citric acid are produced. There is a very clever practical test for ascertaining when the sulphuric acid has been added in excess. The weak liquor being saturated with gypsum, chloride of barium would indicate sulphuric acid long before the sulphuric acid was actually in excess and would therefore be of little use. The manufacturer employs as his test chloride of calcium; this in a liquor saturated with gypsum yields a precipitate only when free sulphuric acid is present: the precipitate takes a little time to form.

The gypsum resulting from the decomposition of the citrate is washed on a vacuum filter, and the citric-acid liquors are evaporated, generally in leaden baths about 9 inches deep, heated by steam. Vacuum pans may be used both in concentrating citric and tartaric liquors, but are more convenient for weak liquors than for stronger solutions evaporated for crystallization. During the evaporation much gypsum is deposited; this adheres to the bath, the clear liquor is run off and concentration resumed. The first crystallizations are by granulation. The hot concentrated liquor is run into a tub provided with a revolving agitator; this is kept in motion for about 24 hours, and the acid is deposited as a granular salt. The mother-liquor is then again concentrated, and a second granulation takes place. From the second mother-liquor a third crystallization can be obtained. The residual liquor is then generally too dark and impure to yield further crops of crystal. and is then known as "old liquor." Granulation may be looked on as a great practical improvement on the former method of crystallizing by standing, the citric acid being separated from the solution in about one fifth the time required for ordinary crystallization. Granulation seems to have been introduced about 1856.

The white salable crystals of citric acid are obtained by redissolving the granulated salt, heating it with animal charcoal, filtering and then crystallizing the concentrated bright liquor in leaden trays about three inches deep. The difference in the solubility of citric acid in hot and cold water is such, that a hot saturate solution almost solidifies on cooling; it is necessary, therefore, to employ shallow vessels for crystallization. The animal charcoal used is free from phosphate of calcium, which is removed by a previous treatment with hydrochloric acid; without this precaution the phosphate would pass into the citric acid.

Commercial citric acid always contains a trace of lead, most of the operations being performed in leaden vessels; if acid is required free from lead, stoneware apparatus must be used.

The "old liquor," which will no longer yield crystals of citric acid, is diluted with water, and precipitated by whiting with the aid of heat, precisely as in the case of the original juice. The citrate of calcium thus obtained is pure and clean; it is decomposed with sulphuric acid in the ordinary way, and the citric acid thus recovered is added to the general liquors. Old liquor is never perfectly neutralized by chalk. The acidity may possibly be partly due to aconitic acid, formed during the long heating of the citric acid liquors; it may also, as already mentioned, be occasioned by the presence of phosphate of iron or aluminium in the liquor.

Samuel Parkes in his essay, published 1815, says that 20 gallons of (raw) lemon-juice will yield 10 lbs. of citric acid. Supposing the juice to contain 12 ozs. to the gallon, this is a yield of only 66 per cent, one third of the acid being lost. In the trade it is usual to speak of 20 per cent as being the loss in making citric acid. This, however, may be taken as the extreme loss, occurring only in years of inferior juice. If the citric acid in the juice is reckoned from its acidity, we may assume the loss in manufacture to vary from 12-20 per cent as its extreme ranges, and depending chiefly upon the season.

The quantity of citric acid made in England in 1875, was about 300 tons. The manufacture has lately been in a depressed state, due to the high price of juice owing, it is said, to disease in the lemon-orchards.

UNHEALTHY TRADES.

A Lecture before the Society of Arts, London, by Dr. B. W. Richardson.

(Continued from page 155.)

Injuries from Inhalation of Gases, Vapors, and Fumes.

From the study of injuries arising from the inhalation of fine particles of solid matters or dusts, named as Order *a* of Class I. in our classification, I pass now to Order *b* of the first class—namely, to the injuries which are induced during industrial labor by inhalation of gases, vapors, or fumes.

Definitions—Physiological Varieties of Action.

By a gas is meant a substance which is only known to us from the first in the gaseous form of matter; which is, in fact, like the gases of the air we breathe, and which is incondensable into liquid under the ordinary atmospheric pressure, at common temperatures.

By a vapor is meant a substance which has taken the gaseous form from a liquid, which is diffused in the air, as the vapor of water may be diffused, and which is derived from the volatilization of some volatilizable body, such as turpentine or bisulphide of carbon.

By fumes are meant matters which are given off at a high temperature from different solid substances used in the arts, such as the fumes of mercury or zinc, or the fumes evolved from heated resin. The fumes may be considered, generally, to be composed of solid substance, diffused in fine distribution, through the agency of heat, in the air. They are condensable, and when they are derived from metals they are usually oxides of the metals.

Gases and vapors, when inhaled by the lungs, act in a different manner from those solid particles of dust which we have considered in the previous lecture. Some of them, when they pass into the larynx and windpipe, are irritating and produce cough; some of these also cause free bronchial secretion, in which respect they resemble dust in the effect they excite. But here the analogy stops. The gases and vapors, diffused within the bronchial passages, are not, as far as we know, influenced by the ciliary motion. Some of them may possibly impede or destroy that motion, but they are not themselves brought back by it. Diffused with the air, and existing in the same gaseous condition, they reach the blood which has been sent by the right side of the heart to the lungs, which has been distributed over the pulmonary capillaries, and is coming in contact, through the fine walls of the air-vesicles, with the atmosphere those vesicles contain. In this manner the foreign gases or vapors reach the blood with the air that is breathed for the purpose of sustaining life, and the blood absorbs them as it does the oxygen of the air.

The gases and vapors, when they are inhaled, exert, as you will see, a deeper influence than the mechanical dusts. They enter the blood-stream, in which they are condensed, in the same manner as the vapors of chloroform, methylene, or ether enter when administered to produce anæsthetic sleep, and so their action is extended from the lungs into the system altogether. They have, in short, a general as well as a local action, and the general action of many of them is so active that they would prove at once fatal, by the constitutional mischief they establish, if their inhalation were long continued.

They differ, also, from dusts in their effects in respect to the methods that are available for preventing their entrance into the lungs. Dusts may be prevented entering the lungs by various mechanical means of filtration. Gases are not as yet capable of filtration, at all events not by such means as are practically applicable in the arts at this present stage of our scientific progress.

What I have called fumes approach nearer to dusts in their mode of action than the gases and vapors do. Some fumes are quickly condensable on the respiratory tract, and these act almost after the manner of dusts; others, which are more easily sublimed, diffuse more freely, and partake, therefore, rather of the quality of vapors.

It would be impossible for me to undertake the description of all the foreign gases, vapors, and fumes to which they who are engaged in industrial pursuits are exposed. In fact, there may probably be many which are not yet known to men of science. Following, therefore, the plan I have hitherto pursued, of endeavoring to extract the pathology out of the industry, I shall notice only those bodies of the class under consideration which are known to be capable of producing certain well-defined phenomena of disease.

Some of these agents are derived from the simplest sources; they give no evidence to the senses of taste, sight, or smell that they are injurious; and those who are injured are subjected for long periods of time, possibly for the whole period of time they are employed, without being conscious of the cause of injuries they distinctly feel.

Effects of Gases.

Carbonic Oxide.

As a first illustration, let me refer to the gas known to the chemist as carbonic oxide.

Carbonic oxide is the product of the imperfect combustion of carbon in oxygen. It is produced in large quantities whenever charcoal or coke is burned in common air, as is so often done in the chafing dish and stove in various industrial occupations. The gas is inodorous, and is most poisonous. I found by direct experiment that one part in three thousand of this gas produced, by inhalation, extremely painful symptoms—namely, giddiness, drowsiness, unsteady movements of the heart, tremulous and convulsive movements of the muscles, and nausea. I also discovered, some years ago—namely, in 1862—the curious fact that prolonged breathing of this gas gives rise, temporarily, to the disease known as diabetes.

Sulphurous Acid Gas.

Sulphurous acid, the gas produced by the burning of sulphur, is used for bleaching purposes, and especially for bleaching straw for bonnets. The plaited straw is brought in lengths to the bleacher. It is first soaked in an alkaline solution of potash or ammonia, and afterwards is exposed to oxalic acid; it is subsequently washed in soap-suds, and lastly is bleached by being subjected in a closed chamber to the fumes of burning sulphur. Into the bleaching-chamber the workman enters to turn and change the straw. The air is irrespirable, but by learning to hold the breath for one or two minutes, the operator becomes skilful in avoiding a dangerous inhalation of the fumes. He rarely escapes altogether from the effects of the gas, and he feels the effect still more after the straw is removed and dried.

The more active symptoms induced by sulphurous acid are those of suffocative cough, which is of short duration when the gas is withdrawn, and does not seem to lead to any serious bronchial mischief. After frequent and prolonged exposure to the effects of the gas, the system is influenced through the blood. The blood is rendered unduly fluid, the diseased condition known technically as anæmia is developed, and biliousness, amounting even to jaundice, is an occasional added disorder.

In connection with the effects of sulphurous acid, I find another class of workers who suffer from it, in conjunction with effects arising from a different cause of injury. The class I refer to are the "fellowship porters." I discover in these men, who are employed in landing merchandise, corn and fish especially, that the workers amongst the corn are affected not only by the dust, which is a source of much irritation, but also by the escape of vapor of sulphurous acid, which exhales from oats that have been bleached by the acid. Oats coming from Ireland are often bleached in this way, and smell strongly of the gas. The admixture of gas and dust is exceedingly irritating to the lungs, and is a cause of bronchial coughs and spasmodic asthma.

Amongst the industrials exposed to carbonic oxide, certain of the symptoms I have named are frequently induced when the workers use burning coke in a closed room. I have found tinmen and braziers suffering from this cause, and the influence of the same is felt by walking-stick makers, and all others who are obliged to stand over the fumes of incandescent coke. After a time the body seems to become, to some extent, accustomed to the gas, but the bad effects are not therefore mitigated, though they may be less severely felt. The chief symptom complained of may be summed up in the one word vertigo. The sufferer tells you he is giddy, that he feels cold, and that his hand becomes unsteady at his labor. He leaves his work for a time, enters into a better atmosphere, obtains relief, and returns to his work again to feel the same symptoms. In the case of a brazier who worked in a small, close shop, and who kept a chafing dish at all times on his bench when he was using heated irons, the symptoms were, at first, those of nausea which passed even to vomiting, flushing of the face, giddiness, as if he were spinning round, and faintness. He became inured to some of these symptoms after a time, but lost appetite, and said he could not help feeling giddy, do what he would, until he was out of doors. Things seemed to be moving before him, and his hand was unsteady. An improved system of ventilation, with a shaft for removing products of respiration, put a stop to these dangers, but he suffered for a considerable time after the cause was withdrawn.

The women who work at the lace frame suffer from carbonic oxide, under some circumstances. In cold weather they are led to place a chafing-dish of burning coke beneath the frame, and directly under their own nostrils, the object being to keep their hands warm for performance of their work, which requires delicacy and precision of hand movement. In this way the women are made to breathe an atmosphere charged with carbonic oxide, from which they suffer severely, at first with acute, afterwards with chronic symptoms. The acute symptoms are headache, giddiness, nausea, faintness, flushing of the face, and irregular action of the heart. The chronic symptoms are, failure of appetite, fœtor of breath, a nervous, hysterical condition, and anæmia, with great depression of muscular power.

It has not as yet been ascertained whether diabetes has been excited by this means, in those who work in an atmosphere containing carbonic oxide, but it has been observed, in corroboration of the experimental evidence I before mentioned, that some men exposed, by accident, to the gas, were rendered diabetic for a period after their recovery from the narcotic effect and from the other immediately dangerous conditions into which they had been cast. Carbonic oxide forms a part of all coal gas, existing in the purest coal gas in considerable proportions, 7.85 per cent. It thus becomes diffused in the air of badly ventilated rooms and shops in which gas, supplied through unsound fittings, is largely employed for lighting and warming. I believe that in this manner carbonic oxide is a common cause of nervous derangement and dyspepsia.—*To be continued.*

NEW ACID.

M. J. Duval has discovered in mare's milk a proximate principle not found in the milk of ruminants. Equinic acid crystallizes in groups of small needles, not volatile without decomposition, of a fragrant odor and peculiar taste. Its reactions with nitrate of silver, perchloride of iron, chloride of gold, etc., distinguish it from hippuric acid.

TREATING CUPREOUS SOLUTIONS.

Messrs. Chadwick & Jardine, of Irvine, have patented some improvements in treating cupreous solutions obtained by Henderson's humid process or otherwise, in order to purify the copper and utilize separated substances. The invention consists in adding to the cupreous solution acetate or other suitable salt of lead in proportion corresponding to the silver salt present. When there is some lead salt in solution, then only what is required to make it up to the proper proportion needs to be added; and when the cupreous solution also contains salts or compounds of arsenic, antimony, or bismuth, then a further quantity of the lead salt corresponding to them must be added.

THE INTERNATIONAL EXHIBITION OF 1876—THE JAPANESE COMMISSIONERS.

JAPAN AT THE CENTENNIAL.

In our Supplement No. 11 we gave a preliminary account of the curious building then in process of erection on the Centennial grounds, illustrative of the Japanese style of architecture. We also presented drawings of the peculiar saws and other wood-working tools, methods, etc., employed by the native Japanese carpenters who came from their distant home at the antipodes to erect the novel building. In continuation of the subject, we now give a drawing of the building as now completed, from *Frank Leslie's Newspaper*, together with portraits of the Japanese Commissioners, from the *Daily Graphic*, and further drawings of peculiar Japanese implements, by our artist. The central portrait is that of Lieutenant-General T. Saigo, the Japanese Centennial Commissioner. General Saigo is one of the leading men in Japan, an Oriental liberator and agitator. He was one of the foremost movers in the deposition of the Tycoon. In 1862 he was banished to a remote island, and there confined in a small cage for three years, until he could neither stand nor walk. He recovered in time to take part in the revolution of 1867 and 1868, since which time he has been a power in the land He is accompanied by Lieutenant Z. Hidaka, at the right, and Hiromichi Kubo, left.

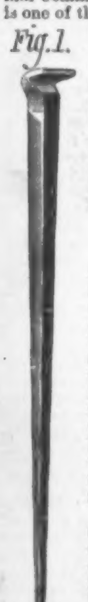
THE INTERNATIONAL EXHIBITION OF 1876.—THE JAPANESE BUILDING.

THE JAPANESE BUILDING.

This building is remarkable for its beauty and elegance of finish. It is regarded as the finest piece of carpenter-work ever seen in this country. The wood of which it is built is most beautifully grained, and as smooth as satin. Every portion of the building is most carefully fitted together, and the carving is truly wonderful. Some persons were inclined to ridicule the leisurely manner in which the Japanese workmen labored, but they find that if the work was done slowly, it was done remarkably well.

The shingles covering the walls are scored by saw-marks running across one another, so as to enable the paper to hold fast. Then a covering of coarse paper is pasted to the boards, another covering of finer paper is added, and then the first coating of plaster is applied. This plaster is white and smooth, having the appearance of stucco or plaster of paris, and contains a liberal admixture of wheat straw cut in pieces of about an inch and a half in length. The second coat of plaster, which is applied after the first one is quite dry, is of similar appearance, and presents, when finished, a very smooth surface. The roof is covered with tiles very remarkable for their lightness and strength; they are about five-eighths of an inch thick, and of a dull, dark slate color. The eave courses are secured by nails such as shown in Fig. 1, and the hip courses are fastened by a tough copper wire.

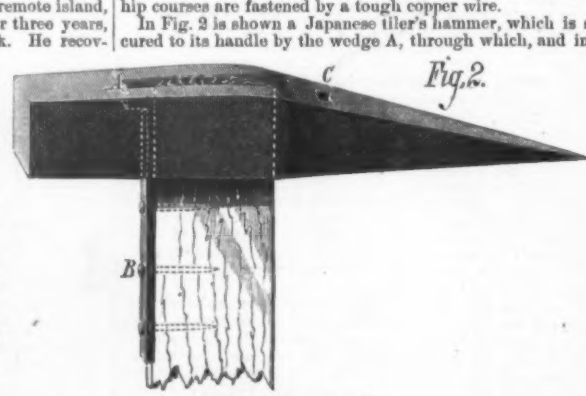
Fig. 1.



JAPANESE NAIL.

In Fig. 2 is shown a Japanese tiler's hammer, which is secured to its handle by the wedge A, through which, and into the handle, are driven the nails, B. C is a square hole through which the copper wire before mentioned is passed, so as to pull it tight in fastening the tiles. The handle is made square, and is about a foot long.

Fig. 2.



JAPANESE HAMMER.

Fig. 3.

JAPANESE OIL-STONE.

Fig. 3 represents a Japanese oil-stone, or, rather, water-stone, since they use hot water instead of oil, and employ two stones, one to rough out and the other to finish the oil-stoning process. The first is of a pale slate color, and cuts very freely; the second is of a pale yellow, and close grained, giving the tools a smooth, polished appearance.

Fig. 4 represents a Japanese marking-line, used for the same purpose as our chalk-lines. The line, it will be observed, is wound around a wooden wheel, and passes through a small hole, and across a cavity tightly stuffed with rag saturated with a red marking material, composed of oil and a raddle similar to venetian red. The rag is stuffed tighter on one than on the other side of the line, so that in being drawn out it will rub tightly against the rag, in consequence of the latter pressing against it to force it out of a straight line. After crossing the recess containing the red marking, the line passes through another small hole, and emerges through the end of the apparatus, and is then fastened to the end of the scriber, as shown in our engraving.

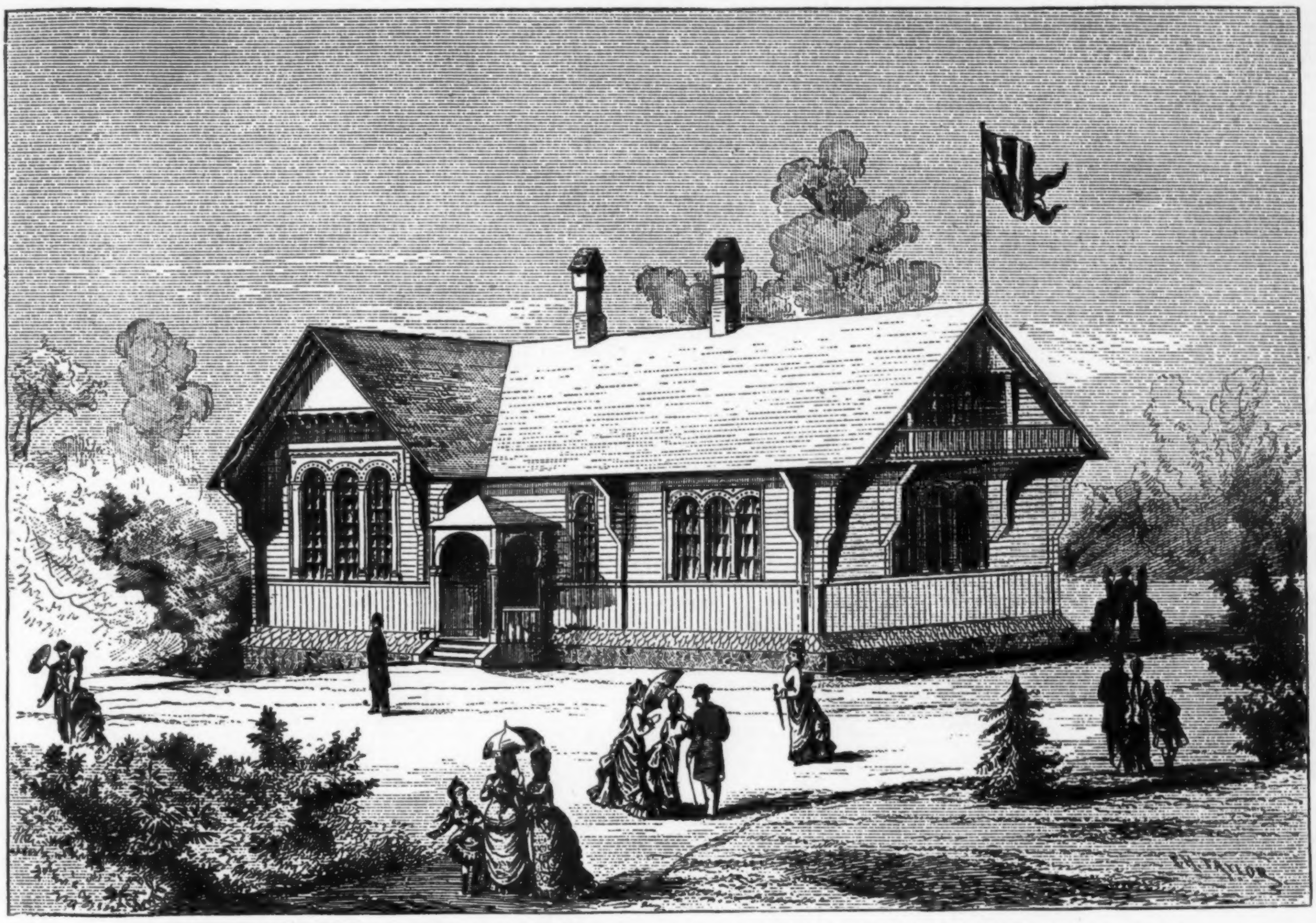
The scriber is a piece of wood having a small spike at one end, which is provided for the purpose of sticking into the plank, thus saving the necessity of holding the line at one end. The other end of the scriber is tapered off, forming a wedge, which will in some instances serve to fasten into an opening, crack, or crevice, where there would be no wood to receive the spike.

Fig. 4.

JAPANESE CHALK-LINE.

DETECTING WOOD IN PAPER.

The following is the best means for detecting the presence of ground wood in paper. Mix one part of aniline oil with two parts of sulphuric acid that has previously been diluted in six parts of water. A drop of this clear solution, if thrown upon paper containing ground wood, will immediately dye yellow every particle of wood it moistens. A still better mixture is three parts of strong nitric acid and one part of sulphuric acid. This, when applied as in the former case, will give the wood an almost brown color.—*Papier Zeitung.*



THE INTERNATIONAL EXHIBITION OF 1876.—THE SWEDISH SCHOOL-HOUSE.—(*See page* 282.)

THE INTERNATIONAL EXHIBITION OF 1876.—ENTRANCE TO THE SWEDISH DEPARTMENT.—(*See page* 282.)

SWEDEN AT THE CENTENNIAL.

(See illustration on page 281.)

One of the most elaborate and useful portions of the display made at the International Exhibition will be that of Sweden, which nation seems determined not to be outdone by any other country. Among other articles included in the exhibit is a complete school-house such as is used in Sweden, and which by order of the Royal Swedish Commission has been erected upon a grassy knoll near the Art Gallery.

Our drawing and the following particulars are from the *Daily Graphic*:

All the wood used in the erection of the house is hard pine, or, as it is botanically called, *Pinus sylvestris*, and was brought from Lake Malaren, near Stockholm.

The school-house is supposed to accommodate fifty children, and, according to the educational regulations of Sweden, contains a school-room not smaller than 40 by 29 feet and 12 feet in height, thus allowing 211.2 cubic feet of air and 17.6 square feet of floor space to each child, while the area of the windows would be 3.6 square feet for every pupil. The hall should be 16 by 12 feet, with a clothes-rack for the children, and in Sweden this corridor is generally warmed by a small stove. As the schoolmaster and his family usually live in the same house, it is customary to make two rooms on the first floor, 16 by 18 and 18 by 12 feet respectively, one kitchen, a pantry, and staircase leading up to the second floor, where there is a room 16 feet square, and a store-room or loft. The ground plan for such a school-house has been strictly followed in the one erected upon the Centennial grounds, except that the schoolmaster's two rooms and kitchen on the first floor have been thrown into one large chamber, in which will be displayed a varied assortment of school-material.

The house itself being a specimen of Swedish carpenter work is, of course, more richly ornamented and finished with a higher degree of art than is customary. The building was designed by Mr. E. Jacobssen, a leading architect in Stockholm, and was manufactured at J. A. Wengstrom's mechanical carpenter's works in the same city. It was brought to Philadelphia in pieces ready to be put together, and was erected by Swedish workmen under the personal supervision of Mr. Magnus Isaeus, Architect of the Royal Swedish Centennial Commission, assisted by Mr. Paulsson. The school-house cost over $10,000, and it will be sold after the close of the Exposition for about one-half of that sum.

Among the material exhibited in this house may be mentioned the following:

1. Books, atlases, engravings, collections and apparatus for instructing the children, and also for the use of the teacher.
2. Everything connected with the architecture or furnishing of a school-house.
3. School and parish library for the use of children, parents, and teachers.
4. Winans' and Bolinder's earthenware stoves, and air purifiers for burning wood and coke, such as are used in Swedish school-houses.

These capital inventions will doubtless attract much attention from visitors.

SWEDISH ARCHITECTURE.

Besides the school-house there will be several other specimens of Swedish joiners' work exhibited in the main building. The ornamental entrance to the Swedish department is shown in our drawing. The wood of which this is composed was brought from the larger carpenter's works at the city of Tidaholm belonging to Baron H. H. von Essen. Another one of the same character from the town of Sandarne will be displayed by James Dickson & Co. All this woodwork, like the school-house, will be varnished, but not painted, in order to better display the quality of the material, and also because no color applied can present a handsomer appearance than the natural wood.

The Baron von Essen mentioned above belongs to one of the most noble families in Sweden, and is the owner of vast forests. Instead of allowing these to lie idle he has the wood manufactured into the finest varieties of carpenter's work, which are sold in Europe and South America. In this manner he gives employment to a large number of workmen who otherwise would be without the means of subsistence, and furnishes a rare and honorable example to European aristocracy.

EXHIBITION NOTES.

SOME ENGLISH EXHIBITS.

The English department is continually receiving fresh accessions in the shape of boxes and cases, and the last arrival included some five pieces of the reproduction of the "America Group" in the Albert Memorial. It is well known that this famous work by the English sculptor Bell is in terra cotta, the great importance of which as an artistic material is now recognized by architects and sculptors alike. But it is not so well known that the fabrication of the group was performed by Mr. Doulton at his potteries in Lambeth. This gentleman is the inventor (as the phrase goes, though it is hardly correct) of the well-known ceramic ware which bears his name, and bids fair to be to the southern potteries of Merry England what Josiah Wedgewood was to the northern and midland. Mr. Doulton has recently arrived in Philadelphia and is here to superintend the placing of the group in Memorial Hall, where it will occupy the place of honor, a dignity it well deserves.

The "America Group" is not by any means the sole display made by the great manufacturer, for he has, I believe, 1100 objects in terra cotta and in Doulton ware, ranging from a superb garden vase, more than 6 feet high, to lovely statuettes which are at present the rage everywhere. The vase and a font are particularly interesting. The body of the font, octagon in form, is of terra cotta, and it is supported by eight pillars of the Doulton ware, blue. These are of a deep cerulean hue, and have a white enameled pattern of some bind-weed design twining round them in a delicate spiral. Between the pillars are panels of the deep blue, which has a very beautiful glaze, by the bye, and in the centre of this is a carbochon ornament or oval boss of a delicate sage green, with a central eye of deep blue again. Round the green is an edging of white. The lower part of the body of the font is ornamented with oval bosses of purple and green alternately, set like gems into the red terra cotta, and in each of the eight facets are panels of the deep blue, sculptured in high relief with scenes of the Saviour's life. At each angle are pillars, the same in substance and design as those below, and on the summit of each is perched a dove of a delicate light blue. The cornice is double, of red terra cotta, and is ornamented with bosses of green and purple. This most beautiful specimen of what the South of England can do in ceramic art is only in two pieces, and it really is wonderful to see no flaws or chips of any kind in such enormous masses, which, by reason of their size, can not be protected while undergoing the operation of baking—at least by any ordinary means.

The great flower vase is of the whitish-brown color well known to people who ornament their gardens with terra cotta, but it has beautiful underlying tones of red. The design is taken from some high relief friezes which Mr. Doulton saw in the Belvedere at Vienna, representing a combat between Greek warriors and mounted Amazons. They were taken from a tomb recently discovered in Ephesus, and have a decidedly archæological value, for they present the Amazonian riders as fighting with long-handled, double-headed axes, with Phrygian caps, from which their long hair streams furiously wild in the ardor of combat, and with shoes, absolute shoes, neither the buskin nor the cothurnus, but the shoe. The Greek helmets are not exactly what classic art represents them, but have a broad connecting band going round the chin and lower part of the face, and plumes which do not fall gracefully backward, but are stretched across the back at right angles. The figures are wonderfully vigorous in pose and action, but are more archaic than beautiful. The shape of the vase is that of a bell with a broad, overhanging rim. Underneath this rim the designer has added a wreathing garland of branches of the vine, with leaves and pendant bunches of grapes boldly and skillfully wrought. The pedestal is adorned with two figures of Amazons seated back to back, with their hands tied behind them, and on the opposite sides are trophies of Greek armor and weapons. But the glory of the whole vase is in the handles, which are formed of horses, in high relief, starting, as it were, away from the scene of combat. The boldness and force of the idea, and the skillful manner in which it has been carried out, will surprise those who are acquainted with the tameness of the usual terra cotta vase forms, and will delight every one.

THE DIAMOND-FIELDS OF GRIQUALAND, SOUTH AFRICA.

By J. B. Currey, Late Secretary to the English Government, Griqualand West.

Griqualand is one of the tracts which, stretching across the continent of Africa from the Atlantic to the Indian Ocean, north of the colony of the Cape of Good Hope, indicate by their nomenclature the tribes which still inhabit them—Damaraland, Namaqualand, Griqualand, Basutoland, Zululand; and the Griquas are a race of mixed Dutch and Hottentot extraction whose presence in the Cape Colony was inconvenient, and who eventually found a home on the high table-land on the northern bank of the Orange River, where they settled in the early part of the present century.

The mines or pits in which the diamonds are found may be described as holes, all of several acres in extent, in the barren shale which covers this part of the country, and which in every case seems to form a distinct wall or reef round the diamond-bearing soil. Outside this wall or reef of shale no diamonds appear to be found. Inside it the diamonds are found in profusion.

Of the four places opened, two were on a farm called Vooruitzigt, one on a farm called Dorstfontein, and the fourth on a farm called Bultfontein, all four places lying within a rayon of about two miles. Of those on the Vooruitzigt property, one was called, first, "Colesberg Kopje," in honor of its discoverers, then "New Rush," from the number of diggers who flocked there from other spots, and finally "Kimberley Mine." The other has retained the name of the De Beers, who owned the farm. That on Dorstfontein has been called "Du Toit's Pan," being the name of a large sheet of water close to it, and that on Bultfontein has retained the name of the farm. The diamonds found in the three first are of every quality, size, and color; those found at Bultfontein are all small and white.

Under the present system, the soil, after being raised and exposed to the action of the air until it has become friable, is passed through washing-machines of simple construction, oscillating or rotatory, worked by hand, horse, or steam power, and the lighter particles are carried off in solution, whilst the heavier sink to the bottom and are reserved for examination in the same way as at the river diggings. There is one fact in connection with this system of procuring the diamonds which may be worthy of attention; it is, that the machines now in use will not work well if clean water be used in them for mixing with the soil. If this be done, the diamonds, especially the smaller ones, are apt to be carried away and lost, but if water largely mixed with clay be used, the diamonds appear to pass through it with greater ease and rapidity than is due solely to their specific gravity, and are found safely imbedded in the heavier substances which are deposited in the bottom of the machines, consisting of the harder and undissolved portions of the soil, which may hereafter yield more diamonds, mixed with quartz crystals and garnets, and fragments of calcspar, iron pyrites, ilmanite, and peridot.

Though every claim-holder must, as has been said, be a certificated miner, it is not now necessary that he should be a digger, and, as a rule, it may be said that he is not. Claims are held by capitalists, merchants, professional men, retired officers, tradesmen, mechanics, and even by minors and children, and the common practice is for the claim-holder to agree with a practical digger to work the claim on shares, the holder paying the rates and taxes, and the digger finding superintendence, labor, gear, and tools, and receiving generally from 50 to 75 per cent of the proceeds. As a rule, the digger at the end of each week brings to his principal, or his agent, the diamonds which he has found, and they are then handed to a broker, who goes round amongst the diamond merchants and disposes of them to the best advantage. Implicit confidence has of course to be placed in the honesty of the working-partner, but it is gratifying to be able to state that cases in which that confidence is abused appear to be rare, and that, as a rule, the arrangement seems to be one which satisfies both parties.

There are no means of forming a correct computation of the number, weight, or value of the diamonds hitherto produced in Griqualand. The sums already paid for them are estimated at from twelve to fifteen millions sterling. I have no means of ascertaining the correctness of that estimate, but I am able to give some idea of the production in 1874, and the greatly increased production in 1875. The diamonds sent away in the former year may safely be said to have averaged not far short of 16 ounces daily, and the yield in the latter was probably nearly half as much again, or 24 ounces daily; this enormous increase in 1875 over 1874 is attributable to the introduction of the washing-machines, by which not only was the newly-raised soil more exhaustively searched, but immense quantities of the soil raised in former years, and thrown aside after what was called dry-sorting, were washed with such good results that persons competent to form an opinion estimated the proceeds of this branch of the industry alone at £20,000 a week. This débris-washing, as it is termed, is eagerly engaged in by great numbers of persons who have not the capital necessary for buying or working claims, and every person holding a miner's certificate can take out for five shillings a month a license which enables him to search for diamonds in abandoned soil, either by setting up his apparatus in such spots near the mine as the surveyor may appoint, or by carting the soil to his own premises if he chooses to buy the right to search for diamonds in it, at prices varying from threepence to one shilling and sixpence a cart-load. This applies only to the Kimberley and De Beers mines, on the Vooruitzigt property, which has been bought by the Government, in which all rights are consequently centred. The right to the diamonds in the other mines and in the débris around them is in dispute between the Government and the owners or quit-rent tenants of the farms.

This, I think, is all that need be said as to the present position of the diamond-producing industry in Griqualand. As regards its future prospects, I believe them to be—as far as the supply of diamonds is concerned—as good as they ever were. In none of the mines has any bottom been reached, and the greatest depth does not exceed 200 feet. There are also the immense accumulations of half-examined débris already mentioned, and, finally, there are the gravel-beds along the course of the Vaal River, in which the diamonds were first found, but which are now almost deserted, though the stones found in them are, as a rule, of better quality than those produced at the dry-diggings.

The social progress of the community has, considering the difficulties to be overcome, fairly kept pace with the development of the different branches of trade, and of the industries in which its members are engaged. Kimberley, Du Toit's Pan, and Barkly are towns where substantial public buildings and stores, neat cottages and trim gardens, are fast taking the place of mining-camps of tents and wagons. There are churches and chapels, banks and newspapers, an excellent high-school, a good hospital, regular postal and passenger conveyances, and an electric telegraph. Traveling artists give operatic and theatrical entertainments. There are balls and dinner-parties. Ladies play croquet, drive pony-carriages, or ride in faultless habits and tall hats; gentlemen course antelopes and shoot partridges, and play whist and billiards at their club.

The necessaries and many of the luxuries of life are brought from every side. Imported articles are brought by trains of mule and bullock wagons from Cape Town, Port Elizabeth, East London, and Natal. The Free State sends excellent beef and mutton, the price of meat being 6*d.* a pound. The Trans Vaal supplies cereals and vegetables. Game is brought in abundance. Springboks are sold for 5*s.*, blesboks for 7*s.* 6*d.*, and wildebusts or gnus for about the same price. Fresh-water fish is supplied by the Vaal River.

The climate is not unhealthy. In the early days, when people lived in tents, and in many cases lay on the ground, fever was common when the heavy summer rains began to fall; but every year, as better house accommodation is provided, there is less sickness. The heat in summer is very great, 110° Fahr. being not uncommon in an iron building, but at the dry-diggings the nights are always cool. In winter snow falls occasionally, and the nights are sharp and frosty. The most disagreeable part of the year is the spring, from September to November, when high winds prevail, with fearful dust-storms; these are followed, as the season advances, by thunder-storms, with torrents of rain, and the whole country is then soon covered with waving grass, and the vegetation of every kind is most luxuriant.

In domestic life the great difficulties are house accommodation and servants. Houses can not, as a rule, be hired, and building, even with corrugated-iron, is a serious matter where all materials have to be brought five hundred miles inland, and mechanics can command £1 a day as wages. Servants' wages are from £2 to £8 a month for Zulu Kaffirs and Indian coolies. Female servants are not obtainable there, and must be brought from the Cape. Firewood is brought in sufficient quantities, but at ever increasing prices. Water, on the other hand, becomes cheaper as more wells are sunk and competition grows. Shops of every kind abound, and goods are sold at reasonable prices.

The business transacted is very large. £5000 a day is often paid for the carriage of goods from the coast; and the town of Kimberley, with its market square and streets choked with huge wagons and teams of oxen, its hurrying crowds of sunburnt diggers, keen-faced diamond-brokers, and native laborers, the roar of many thousands of voices which now and again comes from the great mine in its centre, the life and stir and bustle which pervade it, presents a scene of no ordinary interest, and one which contrasts strongly with the calm, not to say stagnant, repose which marks all the colonial towns except Port Elizabeth.

QUICKSILVER-MINING.

The quicksilver-mines and reduction works of New-Almaden are 15 miles south of the city of San José, Santa Clara County, California, in the Santa Cruz mountains, at an elevation of 1700 feet above the sea.

These mines were first worked for quicksilver in 1845, but the operations were on a small scale, and no record exists earlier than 1850. They have been, and are now, the most productive quicksilver-mines in the world, excepting only the mines of Almaden in Spain. They are developed to a depth of 1300 feet, and the workings extend horizontally, somewhat in the shape of the letter Y.

Between 500 and 600 men find steady employment—the work being actively prosecuted throughout the year. From the 1st of January, 1864, to the 31st of December, 1875, the number of feet of drifting and sinking on the mines of the company, as shown by the records, amounted to 129,724 feet, or 26.24 miles, at a cost of $1,000,000. This does not include the excavations made in extracting ore during the period named, nor any expense for the same.

In 1875 there were used in the mines 2361 kegs of black powder (25 pounds each), and 9350 pounds of giant and hercules powder—the rock in most cases requiring to be drilled and blasted. At the close of the same year about five miles of railroad, underground, were in operation, and over 200 drills were in active use.

The reduction-works consist of nine furnaces, and include the most improved methods for working quicksilver-ores. When the present improvements are finished, they may be considered as most complete and perfect in every respect.

The total product of all the mines on the company's property up to December, 1875, was 606,453 flasks of quicksilver, of 76½ pounds each, or 46,393,654½ pounds. The average percentage of the ore of the New-Almaden for 23 years and 3 months is 14.58. The highest percentage for any year was in 1850–51, when it averaged 36.74 per cent; the lowest was in 1874, when it was 4.29 per cent. The mines are now in a prosperous condition.—*Mining and Scientific Press.*

[American Journal of Science and Art.]

EXPERIMENTS ON THE SET OF BARS OF WOOD, IRON, AND STEEL, AFTER A TRANSVERSE STRESS.

By WM. A. NORTON, Professor of Civil Engineering in Yale College.

AT intervals, during the last two years, I have carried on a systematic series of experiments, with the view of determining the laws of the set of materials resulting from a transverse stress under varied circumstances. The experiments were made with the testing machine which I devised several years since, for the purpose of experimenting on the deflection of bars under a transverse stress. A detailed description of this machine is given in the Proceedings of the American Association for the Advancement of Science, Eighteenth Meeting, August, 1869, (p. 48). The depressions of the middle of the bar experimented on—while under a transverse stress, or remaining after the stress has been withdrawn—are measured by it to within $\frac{1}{10000}$ of an inch. The experiments on set have been fully discussed in two papers read before the National Academy of Science, Washington, (April, 1874 and April, 1875). The first paper set forth the results of the experiments on bars of wood, and contained a detailed account of the course of experiments instituted for the purpose of detecting instrumental errors, and of the precautions taken to reduce the incidental errors, from variations of temperature and other causes, to a minimum. The second paper discussed the experiments on the set of bars of wrought-iron and steel; which gave results generally similar, under corresponding circumstances, to those obtained with wood. I propose, in the present communication, to give a succinct statement of the general conclusions that follow from the whole discussion.

The experimental investigation was prosecuted under three general heads:

I. Sets from momentary strains.
II. Sets from prolonged strains.
III. Duration of set; and variation of set with interval of time elapsed after the withdrawal of the stress.

Each of these embraced several special topics of inquiry. The bars used in most of the experiments consisted of one of white pine, 3 in. by 3 in. and 4 ft. long; another of wrought-iron, ½ in. wide, 1 in. deep, and 4 ft. long; and a third of steel of the same dimensions. The discussion of the entire series of experiments has brought out the following results, as alike applicable to bars of wrought-iron, steel, and white pine.

1. The immediate set—that is, the residual deflection which obtains immediately after the transverse stress is withdrawn—increases in nearly the same proportion as the stress applied; until this exceeds a certain amount, beyond which the set increases according to a more rapid law than that of proportionality to the strains. It is to be understood here that the varying strains are applied at considerable intervals of time.

2. The immediate set augments with the duration of the stress, up to a certain interval of time. In the experiments with white pine, the duration of strain which gave the maximum immediate set, varied, with the strain, from ten minutes to one hour. The immediate set resulting from a prolonged strain, was found to be from five to nine times as great as that which succeeded a momentary strain.

3. The residual depression below the original line of the bar is greater if the stress is reached by a series of increasing weights than if the full stress is directly applied.

4. When the same strain is repeated on the same bar, after a short interval of time, the set first obtained is not augmented, unless the load applied exceeds a certain amount, varying with the material and dimensions of the bar. With loads greater than this limit each repitition of the load augments the total set. The amount of the increase varies with the interval of time since the previous application of the load and the number of previous applications.

5. The set, or residual depression of the middle of the bar, experiences marked variations as the interval of time subsequent to the removal of the stress increases. When the immediate set is less than about 0.0005 in. it passes off in a few minutes (ten minutes or less). When it is greater than this it habitually varies as follows: it invariably decreases for a short interval of time, and then ordinarily increases for a longer interval, with moderate fluctuations. The period of decrease varies from about five minutes to twenty minutes; and is the longer in those instances in which the stress is prolonged. The subsequent increased set, or augmented depression of the line of the bar, may attain in less than an hour to an amount even greater than the set observed immediately after the stress is withdrawn. In some of the experiments the depression increased until it came to be about double that first observed. The proportionate increase of set is usually, however, much less than this. This increase of set is eventually succeeded by another decrease. These remarkable fluctuations observed in the line of the bar were more conspicuous in the experiments with white pine, than in those with iron and steel. The difference was, however, only in degree. Under similar conditions the general character of the fluctuations was the same whichever material was used. The fluctuations observed with the bars of iron and steel, as well as with the wooden bar, far exceeded any errors to which the observations were liable. They were also much too slow, and too prolonged, to be regarded as simple vibrations of the bar consequent on the removal of the downward pressure.

6. Abnormal variations from the general law of variation of the set just noticed, may occur under especial circumstances. Such deviations were observed after the bar had been subjected to repeated strains from day to day. Under these circumstances the bar may be in such an abnormal condition that the set observed immediately after the stress is withdrawn may pass off rapidly, and the line of the bar may even rise considerably above the position held when the stress was applied—though not above its original line some days previously, before any strain was applied.

7. When the load, or stress at the middle of the bar, exceeds a certain amount, the set resulting from one or more applications of the load on any one day is not only still discernible on the following day, but the actual result may be that the middle of the bar may be lower than at the close of the observations on the previous day. Such effects were observed, in the experiments with white pine, when the load was sufficient to produce a longitudinal strain on the upper or lower fibres of 500 lbs. per square inch; and in the experiments with the steel bar, resting edgewise on its supports, when the strain on the outer fibres amounted to 1500 lbs. per square inch.

8. Repeated applications of the same load, from day to day, are attended with an indefinite augmentation of the residual depression of the middle of the bar, if the load exceeds a certain amount. When a smaller load is similarly applied, the set attains after a few days to a maximum, and subsequently subsides more or less. The load answering to the critical point here referred to, is obviously the maximum safe value for a variable load that can be applied, with an indefinite number of repetitions, to the bar. In the case of a white pine stick (3 in. by 3 in., and 4 ft. long) the experiments show it to be less than $\frac{1}{4}$ the theoretical breaking load. Under repeated applications of 500 lbs. (or about $\frac{1}{4}$ the theoretical breaking weight) the set steadily increased from day to day—that is, the middle of the stick became more and more depressed—during the entire period (seven days) that the prolonged effects were noted. Under daily repetitions of a load equivalent to $\frac{1}{10}$ the breaking weight, the depression increased for three days, and after another interval of three days the stick had recovered its original line. The depressions here referred to are those which obtained on the morning of each day just before the first application of the stress on that day.

9. In connection with the phenomena of set which have been signalized, it is important to note that during any interval in which a bar was kept under a transverse stress, the resulting deflection commonly experienced a continual variation. In general the deflection increased as the strain was prolonged. But the deflection of the steel bar in some instances diminished under the prolonged strain. This unusual result was apparently dependent on some molecular condition of the bar, induced by previous strains. The comportment of the wrought-iron bar, as regards varying deflection under a continual strain, was not particularly examined.

It is also noteworthy, in this connection, that the deflection resulting from any single stress was found to be more or less dependent on the previous strains to which the bar had been subjected. The wooden bar, when it had been exposed to a cross strain not long before, was generally in a condition to suffer a greater deflection than it had before experienced under the same load. The same was true of the steel bar during several successive days of experiments with loads of 4 lbs. and 6 lbs.; but as the result of these repeated strains the the bar came eventually to be in a condition in which each renewal of the stress gave, for the most part, a less and less deflection.

10. It is apparent from the foregoing experimental results, that every application of a transverse stress to a bar must induce some change in its molecular condition, which continues, with variations that may be either progressive or fluctuating, for a greater or less interval of time. The duration of sensible influence varies with the amount and duration of the stress. For the smaller strains it is but a few minutes; for the larger several days. The prolonged influence of strains applied from day to day to a bar, was apparent from the fact that the same stress did not on different days produce either the same deflection or the same set. It was strikingly shown in the experiments with the steel bar by causing the bar, to which loads had been repeatedly applied for several previous days, to rest on its opposite side, and comparing the deflection and set with those obtained immediately before the reversal. It was found that the deflection produced by 18¼ pounds was $\frac{1}{15}$ greater than the deflection produced by the same weight just before the reversal; and the set obtained was now many times greater than before. The deflection also now increased with a prolongation of the strain, whereas it before decreased. Also the set now increased for a considerable interval of time after the withdrawal of the strain, whereas it before decreased.

11. There was no discernible limit of elasticity, revealed by the experiments, with either wood, iron, or steel. A perceptible set obtained, with each material, immediately after the stress was removed, however small its amount, until the set fell below the lowest possible determination of which the apparatus was capable (namely, $\frac{3}{10000}$ of an inch, as the experiments were ordinarily conducted). To test the question still farther, the delicacy of the measuring apparatus was largely increased, by the adaptation of a device for magnifying the movements to be observed; and it was found that the least perceptible immediate set was still limited only by the capability of detecting, with the apparatus, minute displacements.

If we take for the limit of elasticity the condition of things at which a *permanent* set is obtained, the case is different. Thus it was found that the set which subsisted after the pine stick (3 in. by 3 in. and 4 ft. long), had been loaded at its middle with 200 lbs. ($\frac{1}{10}$ the theoretical breaking weight), eventually passed off entirely. This was the case whether the stress was momentary or prolonged, and whether it was applied but once or repeatedly. But with a load of 500 lbs. a permanent set was obtained, as the result of a single application of the stress; and repetitions of the stress were attended with a continual increase in the depression of the middle of the bar. It may accordingly be affirmed that a practical limit of elasticity exists, but not a theoretical one.

12. If a bar, on the withdrawal of a transverse stress, fails to recover its original line of position, or, technically speaking, has a set, it is plain that its integrant molecules have not returned precisely to their original positions, and that the distances between contiguous molecules have either increased or diminished—increased in the line of the longitudinal fibres that have experienced a tensile strain, and decreased in the line of those which have experienced a compressive strain. Now we have seen that, as the result of a series of increasing transverse stresses, the set increases continuously with the stress, from the lowest amount capable of detection with the measuring apparatus employed. We must therefore conclude that, after the application of a series of increasing strains, in which the molecules are relatively displaced by minute fractions of their intervening distances, they take up, when the strain is removed, a series of new positions of equilibrium, differing by excessively minute degrees from those previously occupied. We may draw the same conclusion from the experiments on the set produced by a series of direct tensile and compressive stresses, made by Hodgkinson, Chevandier and Wertheim, and other experimenters. This general conclusion, to which experiments on set, under every variety of strain conduct, leads to the inevitable inference that *the effective forces exerted by the molecules on one another have suffered some change of intensity, in consequence of the stress applied to the bar under experiment.* Viewing the residual displacements of the molecules, in their relative positions, as a mechanical problem, we are constrained to regard the effective molecular forces, that take effect at a given distance, as having acquired a different intensity. We have confirmatory evidence of this induced molecular condition of the bar in the fact that all the diverse effects, which may ensue on subsequent applications of a transverse stress, are found to be either less or greater than those previously observed under similar conditions.

13. The fluctuations that have been noticed as occurring in the set with the lapse of time, reveal the fact that the change in the intensities of the effective molecular forces, which results from the temporary application of the stress, is not permanent but fluctuating; and may, according to the amount of the stress applied, rapidly pass off, or, after a partial collapse, be slowly recovered again. It should be observed, however, that the curious fact of the increase of set which ordinarily succeeds the first sudden fall, may be in part attributable to the gradual propagation inward of the greater disturbed condition of the molecules of the upper and lower fibres.

14. The general correspondence in the phenomena of set and altered deflection, that obtain with different materials altogether precludes the idea that they may result, either wholly or in a considerable degree, from irregular strains subsisting in certain parts of the bar before the stress is applied, and which are more or less modified by the stress; as some persons have conjectured. The change that supervenes must be a general one, or one in which all the molecules participate, though in diverse degrees according to the amount of molecular displacement. The especial character of the change, for each individual molecule, must depend upon the kind of strain to which the molecule is exposed, whether tensile, compressive, or shearing; and not on the nature of the material subjected to strain.

15. If, as experiment has established, when the distance between two contiguous molecules has been forcibly altered, the molecules, when again left to their mutual actions, no longer exert, at the same distance, effective actions of the same intensity as before, it is apparent that *the molecules in the act of displacement have experienced some change, either in their dimensions, or in their internal mechanical condition.* This change must result from the change that took place in the mutual action of the molecules when they were urged nearer to each other, or separated to greater distances. It must be experienced by the ultimate molecule, whether this be identical with the integrant molecule or not—that is, whether we regard the integrant molecule as a single ultimate molecule, or as a group of ultimate molecules. For it is plain that a group of ultimate molecules could not undergo an internal change, that abides after all external actions have ceased, unless its constituent molecules have suffered a change, by reason of which they no longer act upon one another with the same intensities of force as before.

It is well known that with Physicists the "chemical atom" has come to be replaced by the "ultimate molecule." Of the probable physical constitution of the ultimate molecule different conceptions have been formed. To those physicists who regard it as made up of a limited number of precisely similar atoms, endued with unvarying forces—of attraction at certain distances, and repulsion at other distances—I leave it to reconcile conception with the legitimate inference to be drawn from experimental results, that the ultimate molecule is liable to a change of mechanical or physical condition, with every slight disparagement it may experience—a change which subsists after the constraining cause of the displacement has ceased to act; and may, under different conditions, either be permanent, or gradually subside with fluctuations.

NOVEL CORK-LEATHER.

By G. E. BLOCK, London, Eng.

I TAKE sheets of cork, and apply, with a brush, to one side of them a coating of india-rubber solution. When dried, I apply a second coating. I then take a piece of japanned cloth, canvas, thin leather, or other such like fabric, and similarly coat it at the back with two coatings of the solution, and then place the coated surfaces of the cork and fabric together, the edges of the pieces of cork being fitted together neatly, so as to form a continuous sheet or layer. The uncoated side of the cork and also another piece of linen, cotton, or other fabric are now similarly coated with two coats of the solution. When the coatings upon the cork and linen are quite dry, the coated surfaces are applied together, and the cork, now coated on both of its sides, is submitted to considerable pressure in a press or stamper, or by rollers.

In order to cause the coated surfaces of cork and fabric to adhere firmly to one another, it is better that the pressure should be applied suddenly, as by a blow, or by stamping or rolling. The two coatings of cementing solution which are thus brought together blend and form a perfect skin, which will bend at will, and which can be turned in any way, and yet always return to its original form without breaking.

As each of the coatings of cementing solution has been allowed to dry before bringing them together and submitting them to pressure, as above described, the solution will not penetrate the outer surfaces of the fabric or material and spoil their appearance.

The artificial leather or cloth produced in the above manner is then ready to be made up into boots, harness, bags, portmanteaus, driving-belts for machinery, or other uses for which leather is now employed.

In some cases also wooden veneers may be applied over the outer coatings of fabric, and the fabric so produced will serve as panels for carriages and such like; or the surfaces of the fabric may be japanned or lacquered.

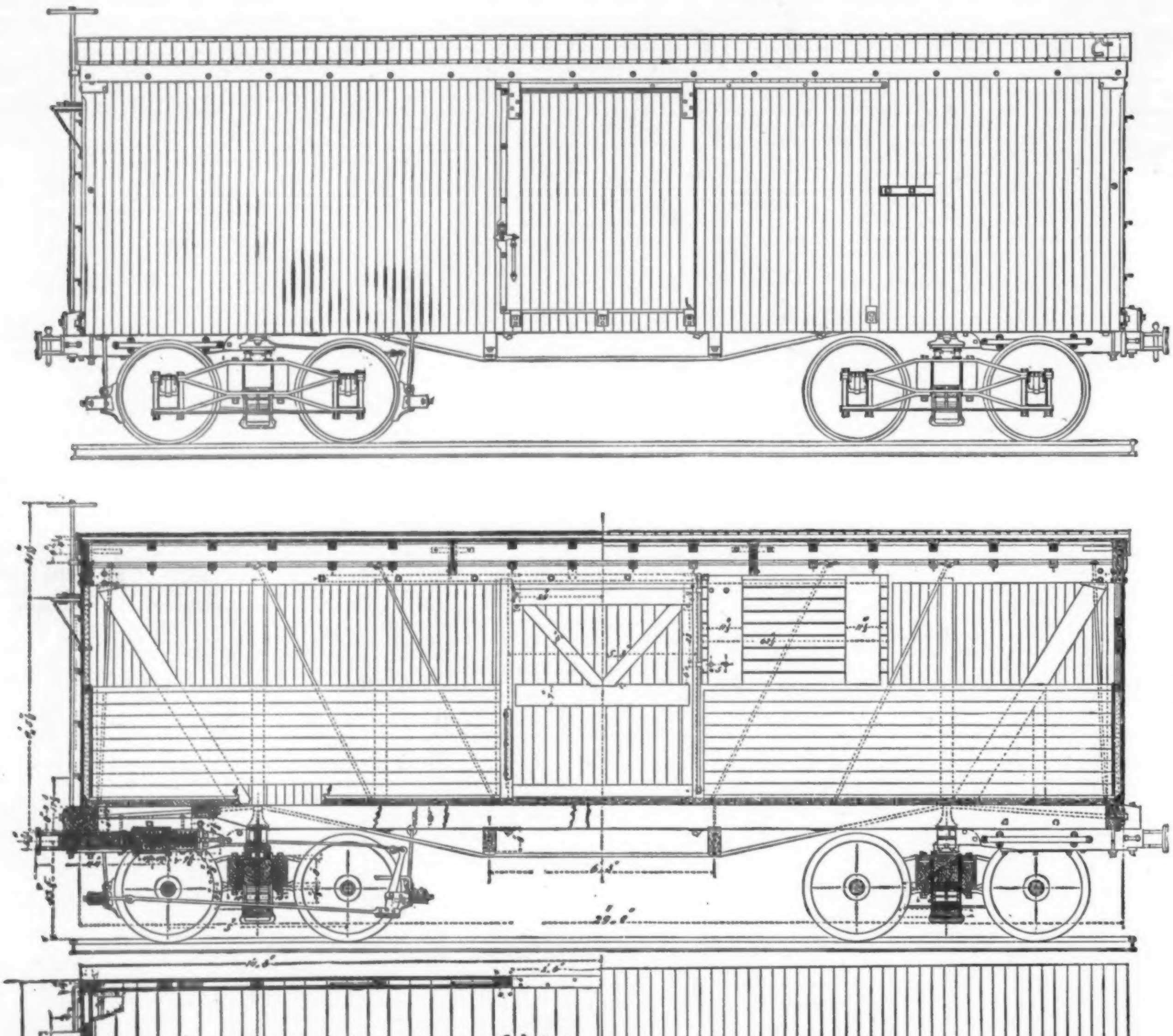
The solution employed is formed from india-rubber cut into small pieces and dissolved in pure coal-tar naphtha. If the solution should get dry while being used, coal-tar naphtha may be added to it to thin down and bring it to the proper consistency.

PHOSPHOR-BRONZE WIRE ROPES.

THE uses of this peculiar alloy appear to be extending rapidly in Europe, while in this country it is almost unknown. Its great strength and resistance to oxidation make it peculiarly well adapted, so far as these qualities are concerned, to many of our present applications of iron and steel.

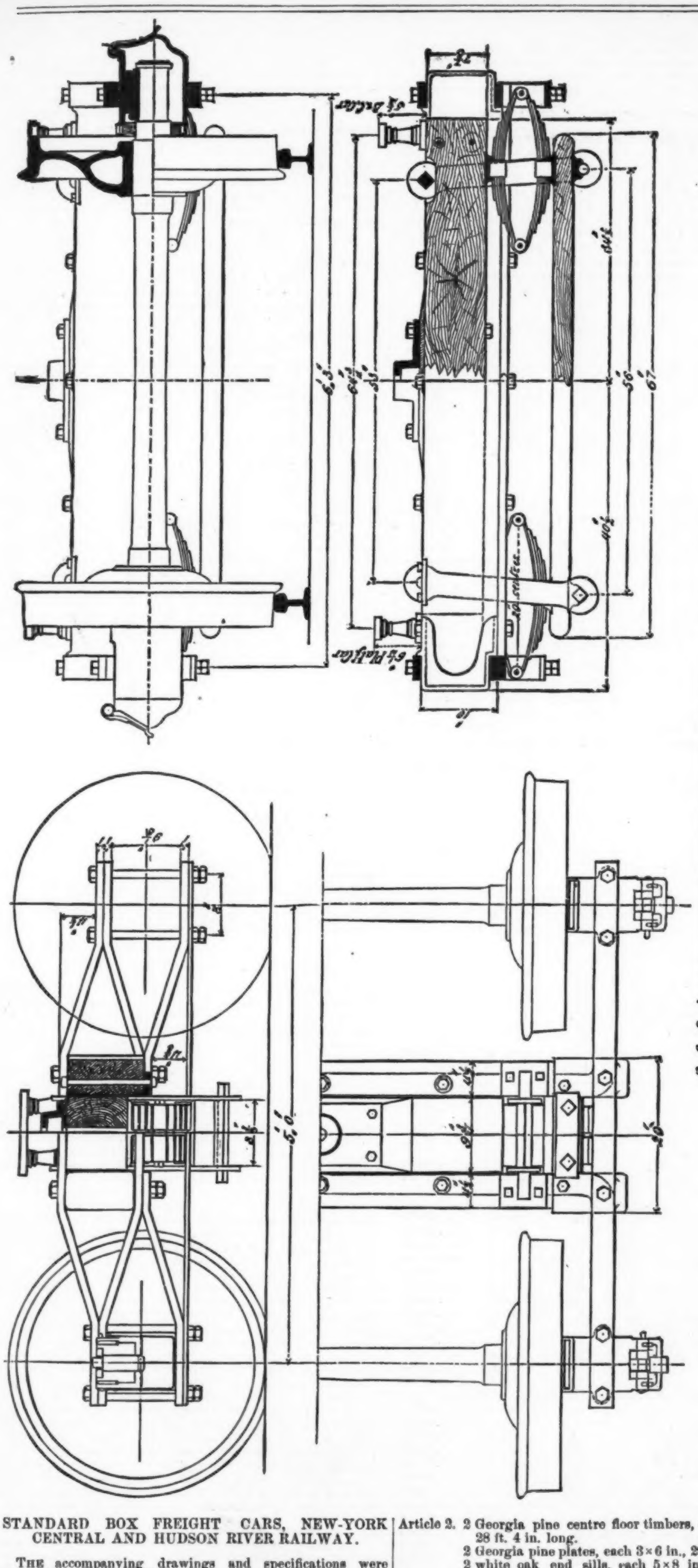
Some practical difficulties have been met with in the working, rolling, and drawing of this new metal—for so it may be called. They consist principally, we believe, in the inability to obtain a perfect uniformity in the metal, and also to anneal it uniformly. That these difficulties are disappearing as greater familiarity increases our knowledge of the properties of the metal, would appear from a recent report of the Phosphor-Bronze Company of London. It is there stated that phosphor-bronze pit-ropes are now in use in Germany and Belgium, several of the highest mining authorities having recommended them on account of the great strength of the metal and its non-liability to rust. When the difficulties in the way of rolling and drawing the metal properly have been overcome, a large trade in phosphor-bronze tubes, pit-ropes, wire, and sheets is anticipated.

It may be of interest to know that "there is money in it," the Phosphor-Bronze Company having earned a net profit of 12½ per cent during the past year. If this can be done in the experimental age of this interesting alloy, and at a time when few old and well-established industries can do more than "make both ends meet," the subject is one worthy the attention of our wire and rope manufacturers.—*The Engineering and Mining Journal.*



STANDARD BOX FREIGHT CAR, NEW-YORK CENTRAL & HUDSON RIVER RAILROAD.

DESIGNED BY LEANDER GAREY, SUPERINTENDENT OF CARS.



STANDARD FREIGHT-CAR TRUCK, NEW-YORK CENTRAL AND HUDSON RIVER RAILROAD.

DESIGNED BY LEANDER GAREY, SUPERINTENDENT OF CARS.

STANDARD BOX FREIGHT CARS, NEW-YORK CENTRAL AND HUDSON RIVER RAILWAY.

THE accompanying drawings and specifications were adopted January 1st, 1876, for the standard box freight-car of the New-York Central and Hudson River Railroad:

GENERAL DIMENSIONS.

Article 1. Length of car outside of siding, 29 ft.
Width of car outside of siding, 8 ft. 8 in.
Height of car from bottom of sill to top of plate, 7 ft. 3 in.
Door opening, 5 ft.

TIMBER FOR BODY OF CAR.

(*Finished Sizes.*)

Article 2. 2 Georgia pine sills, each 4½×8 in., 29 ft. long.
4 Georgia pine intermediate floor timbers, each 3×8 in., 28 ft. 4 in. long.
2 Georgia pine centre floor timbers, each 4×8 in., 28 ft. 4 in. long.
2 Georgia pine plates, each 3×6 in., 29 ft. long.
2 white oak end sills, each 5×8 in., 8 ft. 8 in. long.
2 white oak needle beams, each 4×8 in., 8 ft. 8 in. long.
4 white oak buffer timbers, each 4×11 in., 5 ft. 2 in. long.
2 white oak buffer blocks, each 5½×8 in., 2 ft. long.
4 white oak corner posts, each 3¾×5½ in., 7 ft. 3 in. long.
4 white oak door posts, each 3¾×5½ in., 7 ft. 3 in. long.
14 white oak intermediate posts, each 2×4 in., 5 ft. 4 in. long.
4 white oak braces, each 2×4 in., 6 ft. 8 in. long.
4 white oak braces, each 2×7 in., 7 ft. 4 in. long.
2 white oak carlines for roof, each 2½×12 in., 8 ft. 8 in. long.
14 white oak carlines for roof, each 2½×3½ in., 6 ft. 6 in. long.
2 white oak end plates, each 2¾×14½ in., 8 ft. 8 in. long.
2 white oak ridge poles, each 1¾×6 in., 10 ft. 1 in. long.
1 white oak ridge pole, 1¾×6 in., 8 ft. 4 in. long.
4 Georgia pine roof strips, each 1⅜ in. one edge, 1⅝ in. other, 4 in. wide, 29 ft. long.
1 Georgia pine roof strip for centre, 1¾×3 in., 29 ft. long.
4 white oak door frame stiles, each 1¾×5 in., 6 ft. 1½ in. long.
2 white ash top rails, each ⅞×7 in., 5 ft. 3 in. long.
2 white ash middle rails, each ⅞×7 in., 4 ft. 10 in. long.
2 white ash bottom rails, each ⅞×7 in., 5 ft. 3 in. long.
2 Georgia pine freizes, each 1½ in. thich, 6 in. wide, 29 ft. long.
4 white oak break-hanger timbers, each 4×8 in., 12½ in. long.
Georgia pine flooring, 1¾ in. thick, 8 ft. 6 in. long, and not over 6 in. wide, planed, tongued, and grooved.
White pine siding, ⅞ in. thick, 3 in. wide, planed, tongued and grooved.
White pine inside lining, ⅞ in thick, 5 in. wide, planed, tongued and grooved.
White pine beveled strips on floor below lining, 1¾×1¾ in.
White oak capping over lining, 1¾×3 in.
White pine grain-door, lumber to be ⅞ in. thick, 4 in. wide, 5 ft. 3 in. long, planed, tongued and grooved, and battens for same, ⅞ in. thick, 11½ in. wide, 3 ft. long.
White pine roofing over iron roof, ⅞ in. thick, 6 in. wide, planed, tongued and grooved, free from sap, shakes, large, black, or loose knots, or any other injurious defects.

TIMBER FOR TRUCKS.

(*Finished Sizes.*)

Article 3. 4 white oak cross transoms, each 4½×10 in., 6 ft. 8 in long.
2 white oak swinging spring beams, each 8×9¾ in., 5 ft. 9 in. long.
2 oak spring planks, each 2½×8⅝ in., 5 ft. 7 in. long.
2 oak brake beams, each 4×6 in., 6 ft. 1 in. long.

MODE OF CONSTRUCTION.

(*Framing.*)

Article 4. Side and centre timbers framed to end sill by double tenons as follows: Commencing at top 1½ in. shoulder, 1½ in. tenons, 2 in. space and 1½ tenons; end sill fastened to side sill at each corner by ¾ inch joint-bolts 12 inches long, and one ⅝-inch bolt through side sill, and floor timber 1½ inches from end sill.

Article 5. Centre of bolster 4 feet 10 inches from outside of end sill.

Article 6. Bolster to be made of wrought-iron; top iron ¾×6 in., bottom iron ⅝×6 in., welded at the ends. Bolsters locked into sill and centre timbers ¼ in., fastened to sill with two ¾-inch bolts in each end; centre timbers fastened to bolster with one ⅝-in. bolt in each timber.

Article 7. The needle beams are to be tapered 14 inches from the ends, leaving a lip 5 inches thick under the sills, to be bolted through each sill and floor timber with a ⅝-inch bolt. A casting to be fastened under side for truss-rod bearings; and to take the bolt through floor timbers and needle beams. The needle beams are to be locked on the floor timbers as shown in drawing.

Article 8. The buffer timbers to be fastened to car as follows: Back end of buffer timbers held in position by two cast-iron pockets in bolsters, and bolted to same with two ⅝ inch bolts to each pocket. The front end held in position with two ¾-inch bolts to each timber, passing through end sill and down by the side of timbers, and through a plate ¾×3 inch wrought iron, passing across under both buffer timbers, each bolt to have double nuts; two white oak keys to each buffer timber, 4×4, 2 inches thick, placed between buffer and centre floor timbers, and bolted through with two ⅝-inch bolts.

Article 9. Buffer blocks held in position by two pieces ½×3 inch wrought iron, bent so as to rest on top of end sill and pass under bottom of buffer block, and fastened with two ¾-inch rods, passing through buffer block and end sill, and a cross timber 4×8 inch framed between the two centre timbers, 31½ inches back from inside of end sill, and also fastened to buffer timbers with two ¾-inch bolts, passing through buffer timber, and two ⅝-inch bolts passing through castings on inside of timber and all through a plate of 3×1 inch wrought iron on under side of buffer timbers; bolts to have double nuts.

Article 10. Corner and door posts framed with lip passing across sill and plate, as shown in drawing. Intermediate posts framed with one-inch tenon on inside of posts.

Article 11. Side and end braces to be furnished with cast-iron shoe or pocket, as shown in drawing.

Article 12. Each corner of car to have one ⅞-inch rod passing through plate at head of brace and sill; lower end of rod to be in the joint between end and side sill, and furnished with a wrought-iron washer at each end, 2½ inches wide, 4 inches long, ½ inch thick, with nut at each end of rod; two ¾-inch rods at each end of car, passing through end of plate at head of brace and end sill; nuts and washers at each end; two ⅞-inch and two ¾-inch angle rods on each side of car furnished with wrought-iron washer at top ⅝-inch thick, 3 inches wide, and 6½ inches long, formed as shown in drawing, and fastened to plate with ½×3½-inch coach screw; bottom of angle rods furnished with cast-iron washer 3×6½ inches, as shown in the drawing. The above rods to have nuts at each end; rod to pass through nut at top ¼ inch, and riveted down.

Article 13. Floor to be nailed with 20d. cut nails (2) in each floor timber in all pieces over 4 inches wide, and to be put down crossway of the car, and all pieces to be of full length from outside to outside of sills.

Article 14. Siding to be nailed with 10d. clinch nails, 4 nails in each piece at sill, two in centre, and three in plate, and to be put on up and down.

Article 15. Inside lining to be nailed with 10d. clinch nails, two nails in each board at each post, and a space of two inches to be left between floor and lower edge of lining (a beveled strip to be fastened on top of floor and inside of siding), to be not less than three feet in height, and to have a good white oak capping 1¾ inches thick, well fitted to posts and braces, and fastened with 2½×16 screws.

Article 16. The threshold in doorway to be of cast-iron, ½

inch thick, 3½ inches wide, well fitted to door posts and fastened to floor with screws.

Article 17. The stiles of doors to be halved at top and bottom, and gained in centre 2½ inches to receive the rails, and fastened together with 1¼×16 screws; the corner of stiles to be rabbeted out ⅜-inch to receive siding for outside of door; the doors to be braced from centre of middle rail to top corners of doors; braces to be ⅞×4 inch white pine, all to be fastened together with 1¼×14 screws; doors to have a cap ⅞ inch thick on one edge, ⅛ inch thick on other, 2½ inches wide, to shed water from top door; doors to be 6 feet 1½ inches long, 5 feet 3 inches wide.

Article 18. Outside doors to slide on bar of wrought iron on top ⅝×2 inches, set upon edge and blocked out with castings for that purpose, and fastened with ½ inch countersunk-head bolts through plate; door-hangers to be made of ½×4 inch wrought iron and fastened to top of door with four ⅜ inch bolts; a bar of wrought-iron ½×1 inch to be placed across bottom of door and let in flush with outside face of door and fastened with screws; four cast-iron hooks to be bolted on sill of car, to hook over bottom edge of door, to prevent it from swinging out from side of car. The back edge of door to be provided with wrought-iron wedge or key to fit casting, to keep door up to door posts, and prevent sparks from entering the car; key to be fastened to door with short piece of chain; each door to be furnished with New-York Central seal lock; door stop to be made of white oak 1¾×2 inches, and 6 feet 6 inches long, fastened to door posts with four ⅜-inch bolts.

Article 19. Grain doors to be 3 feet high, hung on ⅞ inch round wrought-iron rod made for that purpose; door when open to swing back and hoist up on top of cap and fastened with button; to be furnished with strip of heavy canvas 3 inches wide, fastened on inside at bottom of door to keep grain from working out.

Article 20. Roofing to be the "Winslow patent galvanized iron roof," to be put on in a thorough and substantial manner, according to specifications furnished by the "Winslow Roofing Company," of Cleveland, Ohio, as follows: All carlines and inside of end plates to be grooved ¼ inch deep for irons, with upper corners rounded, and spaced as shown in the drawings. Two ⅜ inch strap bolts from ridge pole through end plates, with nuts and washers on outside of end plates; strap end of bolts ⅛×2×9 inches long; inside of plate, with ends turned in ⅜ inch, to fill mortise in ridge pole, and one ½-inch bolt through ridge pole and strap 7 inches from end plate. Two wrought-iron straps 2×⅛×18 inches long, one at each joint of ridge pole, with four ¼-inch bolts to each strap. The white pine roofing to be put on with screws. Roofing laid as shown in drawings.

Article 21. The truss-rods to be made of 1¼ inch round wrought iron with enlargement at each end for screw-thread, of 1½ inches in diameter and about 12 inches in length. They are to pass under the saddle, secured to under side of needle beams, and over and supported by a casting resting on top of bolsters made for that purpose; thence passing through the end sill and a cast-iron washer 6 inches in diameter, as shown in drawing.

Article 22. Brake standard to be made of 1¼ inch round wrought-iron, with an enlargement at lower end 8 inches long by 1½ inches diameter, forming drum for chain to wind upon; is to pass through an eye at top and to rest and turn in a step at bottom, as shown in drawing, and to be furnished with a half-circle bearing just above the chain drum; screwed into end sill, forming a bearing for the standard; it is to be furnished with a ratchet-wheel well keyed on; wrought-iron dog fastened to the step, said step to be supported with wrought-iron brackets ½×1½ inches, made in the usual manner.

Article 23. Each end of car is to be furnished with five wrought-iron steps bolted to posts with ½×2½ inch coach-screws; also with handles same style fastened to roof in same manner.

Article 24. The buffers to be of wrought iron, "New-York Central standard pattern," put up with springs, according to drawing.

Article 25. Centre of buffers, when car is light, must be 2 feet 9 inches from top of rail.

Article 26. Centre pins to be made of 1½ inch round wrought-iron, with good, solid heads, 22 inches long under head; the head to rest on top of transom, with provision made in floor for removing pin.

Article 27. The trucks to be of the best quality of wrought-iron, New-York Central "standard pattern." The axles 5 feet from centre to centre, arch bars and frame 1×3 inches, bottom bar below boxes ½×3 inches; all bolts through side of truck to be of ⅞-inch round wrought-iron; all bolts through transom timber and frame to be of ⅞-inch round wrought-iron, and all to have double nuts; brasses to be "Hopkins' patent lead-lined;" all castings and forgings to be exact duplicates of New-York Central standard truck, as shown on drawings.

Article 28. Axles to be of the best hammered iron and Master Car-Builders' standard pattern.

Article 29. Wheels to be ——— tread, guaranteed for ——— years, and to weigh ——— pounds. To be pressed upon axles at a pressure not less than 60,000 pounds. Wheel gauge will be furnished.

Article 30. Brakes to be hung to body of car, as shown in drawing.

Article 31. Each car to be furnished with two metal card cases, secured to siding near car door, made after the standard, 9½×12 inches inside, with wire rack and strip of rubber over top, to keep off the rain, and blocked out on washers ½ inch, for circulation of air.

Article 32. All bolt heads and nuts on inside of car must be let in flush and all sharp corners removed, in order that they may not cut into or otherwise injure the merchandise.

Article 33. All screw threads, bolt heads and nuts must conform exactly to the Master Car-Builders' standard.

Article 34. Painting to consist of three coats well put on. Coloring, numbering and lettering to be as directed.

Article 35. The builder in all cases to protect this company from all patent-right claims, except for such patents as especially directed by the company.

Article 36. A sample truck or any or all castings or forgings used on a car will be furnished, if necessary, at cost.

Article 37. All materials, forgings and castings must be of the very best quality, and all work must be done in a substantial and workmanlike manner, and to the satisfaction of an authorized agent of the New-York Central and Hudson River Railroad Company.

Article 38. Each car is to be weighed and weight marked thereon.

Article 39. The numbers are to be placed on end plate inside of car and on side plate over each door, also on the inside of each door.

Article 40. When compromise or broad tread wheels are used, the initials "B. T." are to be placed on lower right hand corner of car.

Article 41. Springs to be ———

Article 42. All timber, lumber and iron used shall be of the best quality, and subject to such inspection and tests as the railroad company may desire to make.

HYDRAULIC EXPERIMENTS ON A LARGE SCALE.

The last number of the *Transactions of the American Society of Civil Engineers* contains an elaborate paper, describing hydraulic experiments with large apertures at Holyoke, Mass., in 1874, by Gen. T. G. Ellis, being the prize essay for which the Norman medal was awarded in 1875. It is to be hoped that the author will publish an edition of this valuable treatise for general circulation among engineers. Meanwhile a brief summary of the results may be of interest. From the elaborate tables, giving the figures obtained by observation and calculation, the following abridgment has been prepared, which shows generally the results calculated from the means of a number of experiments:

Aperture.	Mean head, measured from centre of aperture. ft. in.	Discharge, in cubic feet per minute.	Co-efficient of Discharge.
Vertical, 2 feet wide, 1.99975 feet high.	2 0 25/32	1683.88	.60871
	3 0 9/16	2008.49	.59787
	3 6⅛	2194.30	.60591
Vertical, 2 feet wide, 1 foot high.	1 9 23/32	773.64	.59757
	3 0 13/32	1003.98	.59902
	4 7 15/16	1242.99	.59820
	5 8	1366.63	.59652
	6 10 13/32	1507.49	.59771
	7 8¼	1595.08	.59781
	8 5 23/32	1678.79	.59915
	9 7¾	1793.89	.60014
	11 3 25/32	1957.42	.60466
Vertical, 2 feet wide, 6 inches high.	1 5 3/32	351.08	.61141
	4 8 15/16	637.56	.60817
	8 6 15/32	853.37	.60686
	9 7 9/16	905.21	.60618
	11 6 21/32	989.81	.60509
	15 0 11/16	1124.26	.60211
	16 11 17/32	1190.55	.60067
Vertical, circular, 2 feet in diameter.	1 9 5/16	1182.44	.58829
	2 7 5/32	1445.64	.59353
	4 5 11/16	1928.31	.60308
	5 10	2227.73	.61012
	6 11 3/16	2437.46	.61163
	8 4¼	2673.35	.61222
	9 7 21/32	2887.76	.61530
Vertical, 1.0000833 feet square.	1 5 27/32	344.00	.58590
	3 8 9/16	553.29	.59844
	4 9 21/32	630.32	.59755
	5 5¼	671.35	.59529
	6 8 21/32	748.24	.59967
	9 9 21/32	898.33	.59612
	9 10 13/16	910.53	.60127
	12 0 1/16	1000.05	.59972
	13 7 9/16	1067.37	.60072
	15 1 9/16	1124.80	.60079
	17 6 23/32	1203.94	.59687
Vertical, circular, 1.0007 feet in diameter.	1 1 13/32	232.86	.57442
	2 4 5/16	342.25	.58856
	4 9 23/32	489.80	.59014
	7 11 21/32	623.12	.58318
	10 10 19/32	741.98	.59431
	12 5 23/32	794.24	.59411
	14 1 17/32	846.78	.59528
	15 7 31/32	892.18	.59562
	17 8 11/16	954.76	.60128
Vertical, circular, 6 inches in diameter.	2 1 13/16	334.19	.60025
	4 1¼	116.00	.60224
	6 4 5/16	144.10	.60534
	7 3 19/32	153.35	.60076
	8 0⅛	160.76	.60177
	9 0 13/32	171.18	.60191
	10 6 3/16	184.38	.60114
	11 11⅛	197.69	.59996
	12 11¼	204.59	.60102
	14 5⅜	215.88	.60064
	15 5 17/32	223.19	.60077
	15 10 3/16	227.71	.60535
Horizontal, submerged, 1.0007 feet in diameter.	2 7 3/16	371.36	.60851
	4 8¼	485.01	.59051
	6 4 31/32	580.88	.60608
	8 1 7/32	646.17	.59982
	8 9 19/32	673.93	.60032
	12 1 1/32	790.17	.60054
	14 2 31/32	859.04	.60131
	16 3 13/32	919.98	.60236
	18 7 31/32	980.36	.59926
Horizontal, submerged, 1.0000833 feet square.	2 3⅞	499.22	.59871
	3 11	573.24	.60174
	7 11⅞	824.05	.60578
	11 6 29/32	990.11	.60464
	14 3 21/32	1112.23	.61100
	16 2 31/32	1174.34	.60584
	18 5 7/16	1250.01	.60459
Horizontal, submerged, 1.0000833 feet square, with curved approach.	3 0⅛	798.40	.95118
	5 9⅛	1091.88	.94533
	10 6 15/32	1472.60	.94246
	13 6 27/32	1672.59	.94337
	18 2 31/32	1939.04	.94370

The first column gives the position, form, and dimensions of the aperture; the next, the mean head under which the discharge took place; the third, the actual discharge as obtained by weir measurement; and the last column, the coefficient of discharge, or the quotient of the actual discharge, divided by the theoretical discharge under the mean head. It will be seen, by an inspection of the table, that these experiments corroborate the statement made by Mr. Trautwine in his *Engineer's Pocket-Book*, that for large apertures, under heads of from 6 to 15 feet, the coefficient 0.62 will give results correct to within $\frac{1}{40}$ part.

Perhaps some readers may have occasion to use the data given in the above table, and would like some further explanation. The theoretical velocity of discharge is the same as would be acquired by a body falling freely under the influence of gravity through a distance equal to the mean head, and the theoretical discharge in cubic feet per minute is equal to the theoretical velocity in feet per minute multipled by the area of the aperture in square feet. The acceleration due to gravity at the place of experiment, as computed by Gen. Ellis, is 32.16107 feet, so that the theoretical velocity of discharge in feet per second for any given case is

$$\sqrt{2 \times 32.16107 \times \text{mean head}}.$$

Suppose one of the cases given in the table is taken as an example; for instance, the sixth experiment on the discharge through a vertical aperture, circular, 1.0007 feet in diameter, under a head of 12 feet $5\frac{23}{32}$ inches, or 12,477 feet. In this case, the theoretical velocity will be

$$\sqrt{2 \times 32.16107 \times 12.477} = 28.329 \text{ feet}$$

per second, or

$$28.329 \times 60 = 1699.74 \text{ feet per minute.}$$

The area of the aperture is 0.7865 square feet, so that the theoretical discharge is $0.7865 \times 1699.74 = 1336.86$ cubic feet per minute. And as the actual discharge is 794.24 cubic feet, the coefficient of discharge is

$$794.24 \div 1336.86 = 0.59411.$$

For a similar case in practice it will only be necessary to calculate the theoretical discharge under the given circumstances, and multiply it by the proper coefficient, to obtain a close approximation to the actual discharge.

A few words of explanation may be added in regard to the last set of experiments noted in the table, where the discharge took place through a curved approach. This was formed by bolting to the plate in which the aperture was cut a wooden frame, 6 in. thick, and curved so as to form a mouth-piece having a section of one quarter of an ellipse, whose semi-axes were 4 and 6 inches. It will be observed that one of the apertures is represented as being 1.0000833 feet square. Gen. Ellis, while generally very minute in his descriptions of apparatus and methods employed, does not detail the means by which he made this delicate measurement, which was probably an exception to the statement (page 27 of essay) that "the standard of measurement used for these plates, and for all the measures in the experiments, was a 3-feet scale made by Darling, Brown & Sharps." In making this very fine estimate, however, Gen. Ellis seems to have omitted one correction—namely, that due to change of temperature—for it will be observed that the same dimensions are given for this aperture in all the experiments that were made with it. A reference to the details of these experiments shows that when the aperture was vertical, the mean temperature of the water was 75.2° Fahrenheit, and that when it was horizontal and submerged, the mean temperature was 71.6°—giving a difference of temperature of 3.6° for the two cases. The aperture was made in an iron plate, and taking the coefficient of linear expansion for a change of 1° in temperature as 0.0000066889, a simple calculation shows that a piece of iron which has a length of 1.00008333 feet at 71.6°, will be 1.0001075 feet long if its temperature is increased to 75.2°, and the area of the first aperture being 1.000167 square feet, that of the second is 1.000225. This criticism may seem over-nice to some, but certainly, if it is proper to take measurements to the eighth decimal place, corrections that may possibly affect the fifth decimal place should not be neglected. In reality any one who carefully inspects the variations in the coefficients of discharge, as given in the above table, may reasonably have some doubt as to whether it is advisable to rely upon them beyond the second decimal place.

A NOVEL PIECE OF MECHANISM.

Mr. Andrew Gaudron, of Detroit, is, after nearly a year of constant labor, about completing a complicated piece of mechanism intended to represent the "Resurrection of General Washington," and which it is his intention to exhibit at the Centennial Exposition. The whole apparatus is inclosed in a cabinet 9 feet high, 3½ feet broad and 2½ feet deep. The lower half contains the machinery, and in the upper portion the diorama is displayed. The scene is a fac-simile of the tomb of Washington. Upon one side stands an American and on the other a French soldier of the present day, while at the side and upon the recess beyond are painted allegorical figures and emblems. The machinery, which is quite complicated, is operated by a spring similar to those used in a clock. When it is set in motion a miniature cannon is fired, a bell is tolled, and a curtain, suspended across the face of the recess of the cabinet, rises slowly, bringing to view the tomb and sentinel soldiers. The latter stand at "an order." In the course of a minute or so the tomb opens, and a fac-simile of the father of his country arises therefrom. Simultaneously, the soldiers face toward the tomb and present arms, and Washington performs the usual military salutation. Then there descends from the clouds an American eagle, holding in its talons a staff, on one end of which is an American flag, and upon the other the national ensign of France, carrying in its beak a laurel wreath with which it crowns the resurrected Washington. The machinery continues to revolve, and the scene is reversed and repeated as often as is desired, each representation requiring about three minutes. The figures are made upon a scale of about three inches to the foot. The heads are carved by Mr. Julius Melchers, and the bodies are minutely correct and properly proportioned. The guns carried by the soldiers are in exact imitation of Springfield rifles, and the costume of the soldiers is patterned after the uniforms of the armies of this country and France. The dress of Washington is the same in color and style as that worn by him at the battle of Trenton. The construction of this curious piece of mechanism has brought out a great deal of ingenuity, and, as can be readily surmised, embodies a great amount of fine skill and workmanship.—*Evening Bulletin.*

An American steam excavator is now at work in a deep cutting at Belshell, near Glasgow, Ireland, on the new line of railway in course of construction for the North British Railway, by Mr. Young, railway contractor. The "navvy" is a powerful-looking machine, and employs three men to work it—an engineer, fireman and craneman, but an additional four men are required to shift the wagons to and from the drop. The machine is capable of filling a wagon in a minute, and performs the labor of sixty hands. It is set upon four wheels on iron rails at the bottom of the cutting, and from the jib of the crane a strong iron bucket is suspended by heavy chains. Four teeth attached to the machine, and projecting about a foot from the mouth of the bucket, tear up the face of the cutting, beginning at the bottom, and thus the receptacle is filled. The machine, which is the first brought into use in Scotland, is the property of Messrs. John Souther & Co., of Boston. The cost of a new machine, including the expense of bringing it from America, is stated to be £3000.

THE BLAST-FURNACES OF GREAT BRITAIN.

In view of the importance attaching to the iron trade, and now more especially concentrating itself on the crude-iron trade, it may not be uninteresting to trace the sources of the manufacture of pig-iron, on which so large a portion of British trade depends, and which has reached now the vast proportions involved in a make exceeding six million tons annually, ten times the amount made in 1830. We shall have a better idea of the growth of the trade, as well as of the localities in which it exists, if we give from the best authorities some account of the blast-furnaces in the United Kingdom, and compare them with those shown by Scrivener's "History of the Iron Trade" to have been in existence since the year 1830. It will not be supposed that the total increase has been simply a numerical one, for it is well known that there has been vast increase in the proportions and the powers of production of nearly every furnace in the Kingdom, within a much less period of time than the forty-five years comprehended in the interval alluded to.

In 1830, as now, Staffordshire had the largest number of furnaces. At the time indicated it had 123 furnaces, in groups from one to four; at present, South Staffordshire and East Worcestershire are classed together as having 163 furnaces, and North Staffordshire as having 43. It is interesting to notice in the details forming these totals that at the earlier date Chillington and Parkfield owned two and four furnaces respectively, and they now each have five; that Millfields then, as now, is returned as having four; that Priestfields, Bilston Brook, Barbersfield, Caponfield, Deepfields, and several others then existent, have added little to their numbers; and this extension is seen largely in the districts of Walsall, to the west of Dudley, and in North Staffordshire. Next in order there was the South Wales district, with 113 furnaces, grouping from one to twelve—the latter being the proportion of the Dowlais furnaces, which now are 18 in number. The 113 of 1830 are now 174 in the district of South Wales and Monmouth, by far the largest proportion being now in the Glamorgan district, in which the Cyfarthfa, the Abernant, the Plymouth, and other large sets are comprised. Shropshire stood third in 1830, there being then 48, whilst in the present district included under that name there are now 24. Yorkshire follows with 27 in the earlier period, and in which, excluding Cleveland, in the latter there are 54, nearly every one of the seats of manufacture in the West Riding showing an increase in the number of seats. Derbyshire had 18 where now 54 are enrolled. Northumberland and Durham had then four, and it is here and in Scotland that the large increase is begun to be appreciated, and a little more detail is necessary.

Scotland is only credited with 27 blast-furnaces in 1830 at ten places. The famous Gartsherrie works, now having sixteen furnaces, had one only; one dozen of the Coltness Company were not then existent; and at Monkland there were two instead of six. Altogether Scotland has now, in sets from two upwards, 154 furnaces. The Cleveland district is entirely new. In Cleveland proper there are about 97 furnaces; in the district which may be styled the north-east district there are some 64, and they are dispersed in groups from two each at Loftus and Norton to 12 at Port Clarence. The northwestern district is almost entirely new, and it now comprises 95, the largest groupings being between Cronforth and Barrow. Northamptonshire has now 16 furnaces, Lincolnshire 19; and there are other smaller districts. We may tabulate them in contrast thus, prefacing the table with the remark that the districts are not identical in the two years, but they are sufficiently coterminous to allow of at least an approximate comparison:

District.	Furnaces in 1830.	Furnaces. in 1876.
South Wales and Monmouth	113	174
North Wales	—	13
South Staffordshire and East Worcester	123	163
North Staffordshire	—	43
Scotland	27	154
Cleveland and Northeast	4	160
Northwest	—	95
Yorkshire	27	54
Derbyshire	18	54
Shropshire	48	24
Northampton	—	16
Lincolnshire	—	19
Gloucester, Wilts, etc	—	18
	360	987

This statement is exclusive of the number of charcoal-furnaces, which was small in 1830, and which is now stated to be reduced to three. There are now, however, in course of erection six new furnaces in the Cleveland district; seven or eight are being built in the northwest; in the Shropshire and Staffordshire districts four are being built; six are in course of erection in the Midland counties, one in Glamorgan, and three in Scotland. We may, therefore, set down the productive power of the kingdom in this year as one thousand blast-furnaces as against four hundred immeasurably smaller ones in 1830.

It is difficult to ascertain exactly the proportion of the furnaces now in blast; but it may be said with tolerably certainty that it does not now exceed 600. It must be always the case that a certain proportion of furnaces need repair, and there are local circumstances affecting others; but it is evident from these figures that a very large number are closed from trade exigencies. The Staffordshire and Welsh districts have proportionately the largest number of furnaces blown out; and though in the older districts this would be naturally the case, yet the large proportion there and in the north-west point to the greater depression of trade in these centres than in the Cleveland district—in which, moreover, the furnaces closed are chiefly those of works more distant from coal and coke supplies. These facts point to a further development of the manufacture of crude iron in Cleveland, and though there may be other fields added—in the county of Rutland and in some of the Midland counties there will be a further development—yet for crude iron it appears probable that "northward the star of empire wends its way." Since 1830 there have been built above 150 furnaces (nearly all erected since 1851), and the cost is conjecturable from the statement that two of the latest cost £32,000 each. There is no need to dilate on the effects this investment of capital has had locally, and it is equally needless to point to the position which the north-eastern district has taken in the national manufacture of iron, and which must increase so far as present probabilities give any ground for judgment. But that position nationally which Britain has—that of being the greatest iron-producing country in the world—is one which in the future will need further periods of development to maintain amid the increasing competition which other countries now keep up in the race of production. It is true that America, our greatest rival, in the year 1875 has produced much less pig-iron than it did in the previous year, and it is also true that the number of furnaces in that great continent is much less than in the United Kingdom, and that the number in blast at the end of the year was much below those at work here, but the causes for this are well known, and in the future the number of furnaces in the United States will increase the quicker after the check it has for some time known. We have still supplies of iron which are practically unlimited; we are developing these quicker now than of yore; and when the demand for iron really revives, we can bring an unexampled supply into the market, so that for a time we may preserve that fame, if we can keep our supply at the rate which the fields of America, larger but less developed, will enable her to do.—*Capital and Labor.*

NEW METHOD FOR THE DETECTION OF COPPER, CADMIUM AND BISMUTH.

By Malvern W. Iles, Ph.B., School of Mines, Columbia College.

While working upon the ferro and the ferricyanides of nickel and cobalt, with an object to a qualitative detection of nickel in the presence of cobalt, I was led to study the reactions of the various other metals with the re-agents above mentioned. Some of these reactions were so striking that a qualitative separation immediately suggested itself.

The wet reactions for bismuth and cadmium have always been a source of annoyance, and the valuable aid of the blow-pipe has almost invariably been used by the chemist to decide the presence of these elements. While recognizing the delicacy of the blow-pipe methods for the detection of copper, cadmium and bismuth, and the blow-pipe as a most useful auxiliary to qualitative work, I think the chemists will bear me out in the statement that the *test-tube* and not *charcoal* is the proper place for the detection of substances in a qualitative laboratory, and that the blow-pipe methods should be only used as a confirmatory test.

My mode of procedure may be briefly stated as follows:

Use the scheme for the H_2S group up to the point where Cu., Cd. and Bi. are obtained in solution together; then proceed with the following scheme:

SCHEME FOR Cu., Cd. AND Bi.

Add $6 K Cy Fe_2 Cy_{12}$ to slight excess; next add solid K Cy and gently heat—the Cu. and Cd. are dissolved, while the Bi. remains as a hydrate—filter.

<table>
<tr><th rowspan="2">Residue.</th><th colspan="2">Filtrate.</th></tr>
<tr><td colspan="2">Contains Cu. and Cd.; divide into equal parts.</td></tr>
<tr><td rowspan="2">White flocculent ppt = $Bi_2(HO)_6$.
This may be confirmed on charcoal by use of the B. P. and the (KJ+S) mixture.</td><td>Solution A.</td><td>Solution B.</td></tr>
<tr><td>Add $(NH_4)HO$, then $(NH_4)_2S$ and gently heat—a yellow precipitate = Cds.</td><td>Add HCl (dil) to strong acid reaction; a reddish precipitate = $Cu_3Fe_2Cy_{12}$.</td></tr>
<tr><td>Bi.</td><td>Cd.</td><td>Cu.</td></tr>
</table>

The basis of the above scheme may be stated as follows:

1st. The complete precipitation of copper, cadmium and bismuth by potassium ferricyanide.

2d. The solubility of copper and cadmium ferricyanides in potassium cyanide.

3d. The decomposition of bismuth ferricyanide into bismuthic hydroxide, by the action of potassium cyanide.

4th. The insolubility of cadmium sulphide, and the solubility of cupric sulphide in potassium cyanide.

5th. The insolubility of copper ferricyanide, and the solubility of cadmium ferricyanide in hydrochloric acid.

New-York, March 29, 1876.

PREPARATION OF PURE ANILINE.

By M. A. Rosenstiehl.

The separation of bodies of similar properties often presents considerable difficulties; I have experienced it, in these latter years, in trying to prepare aniline free from pseudo-toluydin. At the time when I discovered this last alkaloid I proved its presence in all anilines, of whatever origin they may be, and especially in that of indigo, which passed then for one of the purest. I indicated also the means of preparing aniline, not giving, with chloride of lime, ether, and acidulated water, the characteristic reaction of pseudo-toluydin. I have since succeeded in increasing the sensibility of this method of testing, and, with its aid, I have still been able to detect the presence of this alkaloid in the same aniline, which then appeared to me pure. I have sought for a proper procedure to remove this little quantity of pseudo-toluydin, so as to obtain a product no longer giving a reaction with my new method. The unexpected difficulties met with form the subject of this note.

To test an aniline I prepare a watery and limpid solution. Dissolving 3.2 grs. in 100 grms. of water, at 17° C., to 10 c.c. of this solution, I add 10 c.c. of chloride of soda (obtained by the double decomposition of liquid chloride of lime of commerce, at 7° Baumé, and a cold saturated solution of carbonate of soda). The proportion of chloride of soda may vary from single to double without inconvenience. The fugitive coloration of Runge immediately manifests itself; I agitate with 10 c.c. of ether, which I preserve; I reject the watery liquid. The ethereal solution is washed with a little water; the washing waters are in their turn agitated with a little ether, which is added to the principal portion; this is then shaken with a little acidulated water. If we had pure pseudo-toluydin or aniline, say prepared from indigo, the acidulated water would take subsequently the violet-red coloration of pseudo-toluydin; but with purified aniline the characteristic reaction is no longer observed: we may say that the coloring matter formed is so weak that it is masked by brown matters and the greenish blue precipitate which the aniline produces.

This acidulated watery solution is now the first matter containing signs of the presence of pseudo-toluydin. It is then shaken several times with small portions of ether, which carry off the brown matters; they are rejected. The watery portion is rendered alkaline by some drops of caustic potash, and agitated with ether, which seizes the coloring matter; the watery portion is rejected, and the ethereal liquid is added to it with a little acidulated water; we agitate it, and let it settle. In the first moments the coloration is not perceived: a slight greenish blue precipitate in suspension hides entirely the violet-rose solution of pseudo-toluydin, but after it has settled some hours this coloration will appear in all its beauty.

The pure aniline which was left from my former experiments was converted into oxalate, and the salt crystallized four times in water, then dissolved in alcohol, from which it was precipitated by ether, in which oxalate of pseudo-toluydin is soluble. This operation was repeated twice, but without success. I have not obtained aniline which did not give the rosy coloration.

Benzine from benzoic acid yielded an aniline with which I obtained very strongly the reaction from pseudo-toluydin.

Fifty grms. of anthranilic acid, well crystallized, were dissolved at 150° to 160° in vacuum; the colorless aniline was distilled into water; the yield was 60 per cent—calculation requires 60.5 per cent. The splitting up is very definite, and, notwithstanding this, the aniline gave distinctly the reactions of pseudo-toluydin.

Twenty kilos. of crystallized benzine, melting at + 4.2°, was melted, congealed, pressed ten times in succession, during the cold weather of the winter 1872–3. The point of melting rose little by little to + 5.5° C., at which point it remained stationary. There finally remained 5 kilos. of benzine, which was submitted anew to fractional crystallization: the mother-liquor and the crystals present the same melting-point. I transformed this benzine into aniline; the oxalate of this base was re-crystallized three times in alcohol, then decomposed by caustic soda. This aniline having still given strongly the reaction of pseudo-toluydin, I made with it several trials to remove the latter. I utilized, in the first place, the solubility of pseudo-toluydin in water, of which 100 parts at 17° dissolve 1.3 parts. By six successive washings the half of the aniline was taken up by the water; what remained gave a reaction, of which the intensity was only half that of the original aniline: it was not possible to pass this limit by new washings. Fractionated saturation with sulphuric acid, followed by distillation in a vacuum, gave no better result.

We know that aniline exposed to air grows brown; if it is then exactly saturated with an acid, there arrives a moment when all the mass is colored red: this coloration is due to pseudo-rosanilin, which is formed in the cold by slow oxidation of the alkaloids. I have finally used this reaction to get rid of the pseudo-toluydin. After preliminary trials I was obliged to renounce the employment of warm air traversing boiling aniline. I finally stopped at this method of working: We pour aniline in a flask filled with blotting-paper, so as to wet all the paper, and to offer to the air a great surface of action. This flask, stoppered up, is exposed to the air and to the sun during three months: at the end of this time, during which it was frequently opened and agitated, it is fitted with a connecting tube, placed in an oil-bath, a vacuum is made in it, and the aniline withdrawn by distillation. The paper, after this operation, is sprinkled with acetic acid, and colors quickly to an intense rose (rosanilin). The alkaloid thus treated still gives the reaction of pseudo-toluydin, but very faintly.

To sum up, this investigation has taught me that the repeated crystallization, in water, alcohol, and ether, of salts of aniline or of matters which serve for its preparation, such as anthranilic acid and benzine, is an insufficient method for separating its homologue. There is only the chemical action of the air which has led to an approximately satisfactory result: from the difficulty of removing pseudo-toluydin we may conclude what it would be to remove toluydin, although its presence has not been shown for want of a sensitive reaction.

All the methods of separation that I have employed are less perfect than the method of analysis. By the substitution of this method for the old one I have discovered pseudo-toluydin where formerly I had inferred its absence, which shows at once that the purity of bodies prepared with the greatest care is only relative. Absolute purity is a limit, driven back without cessation by the perfection of our methods of analysis.—*Comptes Rendus.*

LIFE-BOAT SERVICE.

In view of the recent disaster near Life-Saving Station No. 4, District No. 6, North-Carolina, at the wreck of the Italian bark Nuova Ottavia, off Currituck Beach, in which the keeper and his crew of five of the surfmen belonging to the station, and one volunteer from the party engaged in constructing the light-house at Whale's Back, in addition to nine of the crew of the Nuova Ottavia were drowned, the Treasury Department calls the attention of keepers and surfmen to the importance of always wearing, when using the boats, the cork life-belts furnished for them.

It appears from the report of the superintendent of the district, after an investigation of the circumstances, that the loss of the lives of the crew of the station, at least, would have been avoided but for the neglect of the keeper and surfmen to wear their life-belts, while it is probable that had they not perished they would have succeeded in rescuing the crew of the bark. Their loss is rendered more lamentable by the knowledge that they failed to use the means provided for their safety by the Department, which they should have remembered were essential to their efficiency in saving human life.

The brave and eager spirit of the crews is commendable, says Secretary Bristow, but they should not forget that on their prudence, no less than on their courage, depends the successful issue of their struggles with the sea, and that they owe it to themselves, to the service they honor, and to the shipwrecked whom they toil to save, to avail themselves of every means devised to protect and make them helpful.

Keepers are strictly charged to see that every member of their respective crews is properly equipped with his life-belt before taking his place in the boat on any occasion, and they will be held responsible for any infraction of this order.

A FINE WEEK'S WORK.

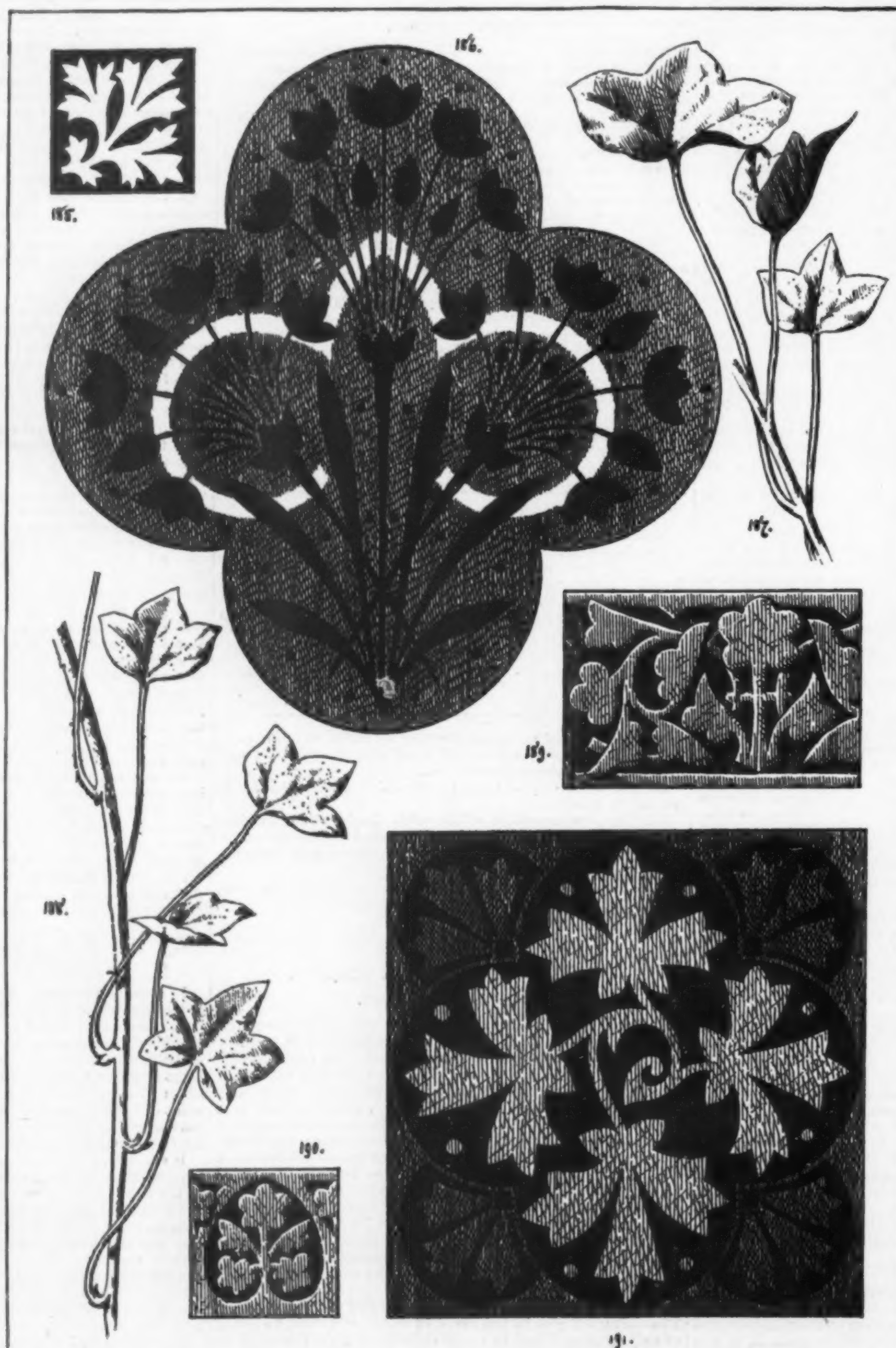
The Edgar Thomson Steel-Works, during the week ending February 19th, made 119 heats, producing 707$\frac{120}{2240}$ tons of ingots, bloomed 709$\frac{1540}{2240}$ tons of ingots, and rolled 560$\frac{1713}{2240}$ tons of rails, of which 25 were of 60-foot lengths, for the Beaver Bridge, on the Fort Wayne Railroad. In accomplishing this extraordinary work but eight vessel-bottoms were used, giving an average of 14$\frac{7}{8}$ heats to each bottom, and using but one cupola. The steel produced was of the best quality. This is believed to be the best week's work on record for single turn. No extra effort was made to effect this large production, and this can be taken as a fair indication of what these works are capable of doing.

[Building News.]

SUGGESTIONS IN FLORAL DESIGN.

THE inflorescence of plants, the arrangement of their blossoms, is a feature of great ornamental value. In some plants, as in the common daisy, a large number of flowers are congregated together into what is called a flower-head, and what is ordinarily called a daisy flower is really an aggregation of some dozens of blossoms. In the plantain the blossoms are all arrayed in a spiral round the central line, while in a wheat-ear they are placed alternately. When the blossoms, as in a hyacinth, are each placed on a short stem, instead of directly on the elongated axis, another marked type of inflorescence is created When the stems of all the blossoms appear to spring from the same point we get the very characteristic and beautiful form known as the umbel; we see it in the flowering rush, of which we have an adaptation to art purposes in Fig. 186; in the cherry, cowslip, and many other plants. Many other varieties of inflorescence may be met with, but those described above are the types that will be found of greatest ornamental value.

Plants are often powerfully affected either for good or evil by various external and foreign influences. Of these, however, we need here only mention one—the effect of light on the growth. Plants will always, if possible, turn to the light, and if a plant that has stood undisturbed for some little time in a window opening be turned round, the difference in its appearance is very marked. We have sketched in Figs. 187, 188, two sprays of ivy, in the one case an ascending, in the other a descending stem; but in either we have no difficulty, on the most cursory glance at the foliage, in determining in which direction the rays of light penetrated the dark corner from which we gathered them. A study of the effect of light on the bramble, jasmine, hop, honeysuckle, and many other plants will reveal as striking proofs of its power to modify the general arrangement of the foliage. Figs. 189, 190 are suggested by the leaf of the mallow, while the maple leaf has supplied the basis of the two sketches marked 185 and 191.—F. EDWARD HULME, F.L.S., F.S.A.



SUGGESTIONS IN FLORAL DESIGN.

THE CARNAUBA TREE.

IN a report by Mr. Consul Morgan on the trade and commerce of Brazil, recently laid before Parliament, occur the following remarks respecting the Carnauba tree:

"Amongst the most useful trees in Brazil, and which deserves special mention, is the Carnauba (*Copernicia cerifera*), a palm-tree which, without any culture, develops itself in Ceara, Rio Grande do Norte, Bahia, etc. Perhaps in no country is a plant applied to so many and varied purposes. It resists the most prolonged drought, and preserves itself constantly luxuriant and green. Its roots possess the same medicinal effects as the Salsaparilha. From the trunk are obtained strong fibres, which acquire the prettiest lustre, as well as corner pieces of timber and excellent palisades for enclosures.

"The Palmetto top, when young, serves as an appreciable and nutritious food; and therefrom also wine, vinegar, and a saccharine matter are extracted, as well as a kind of gum similar in its taste and properties to sago. This plant has often served during the period of excessive droughts as the means of support to the populations of the two first-named provinces.

"From the wood and trunk of the tree musical instruments are made, as also tubes and pumps for water. The delicate fibrous substances of the pith of the stalk and its leaves make a good substitute for cork. The pulp of the fruit is of an agreeable taste, and the nut, oily and emulsive, is, after being roasted and reduced to powder, used as coffee by many persons in the interior. From the trunk of the tree a species of flour similar to maizena is extracted, as well as a liquid resembling that of the Bahia cocoa-nut. From its dried straw, mats, hats, baskets, and brooms are made, and of this straw large quantities are exported to Europe, where it is employed in the manufacture of fine hats, the whole value of which exportation and of such as is utilized by national industry amounts now to about 1000 contos, or £117,500 per annum.

"Finally, from its leaves is produced the wax used in the manufacture of candles, which has an extensive consumption in the northern provinces, especially at Ceara, where it has become an important branch of industry. The annual exportation of this wax is calculated at 871,400 kilos., exceeding in value reis 1,500,000, or £162,500."

AN extensive tract of land, consisting of seven thousand acres, on Maple river, Dacotah, has been purchased by Eastern capitalists for a great wheat farm.

PAPER FROM BAMBOO AND SUGAR-CANE.

MR. T. ROUTLEDGE, who will be remembered as the introducer of esparto grass as a material for paper-making, has recently issued a pamphlet, printed on paper made from bamboo, in which he gives an account of some experiments recently carried out by him with a view of testing the applicability of bamboo fibre for paper making.

Mr. Routledge believes that, with his new system of treatment, bamboo will prove to be as superior to esparto in every respect as esparto was found to be superior to straw. The following is a brief sketch of the way in which he proposes to deal with bamboo for the manufacture of fibrous paper-stock: "First and foremost it is essential to operate on the stems of the plant when young, and preferably when fresh cut. Brought to a factory in this condition, the stems are passed through heavy crushing-rolls, in order to split and flatten them, and at the same time crush the nodes. The stems are then passed through a second series of rolls, which are channelled, or grooved, in order further to split or partially divide them longitudinally into strips or ribbons; these being cut transversely into convenient lengths by a guillotine-knife or shears, are delivered by a carrier, or automatic feeder, direct to the boiling-pans." Both the boiling and washing processes ordinarily in vogue for producing half-stuff or semi-pulp Mr. Routledge conducts in a battery, or series of vessels connected together by pipes or channels, furnished with valves or cocks, so that communication between the vessels may be maintained, disconnected, and regulated as desired, in such manner that the vessels being methodically charged in succession, the heated lyes (composed of caustic alkali) can be conducted from vessel to vessel. The lyes are thus used again and again (each successive change or charge of lye carrying forward the extractive matters it has dissolved from the fibre with which it has been in contact) until exhausted or neutralized (when they are discharged), fresh lyes being methodically and successively supplied, until by degrees the extractive matters combined with the fibre have been rendered sufficiently soluble, when hot water for washing or rinsing is, in the same continuous manner, run from vessel to vessel, until the extractive matters rendered soluble by previous alkaline baths have been carried forward and discharged, leaving the residuary fibre sufficiently cleansed. A final cooling-water is run on and through the fibre, which is then drained, and the contents of the vessel are placed in a press, in order to abstract as much of the remaining moisture as possible. The dry or semi-dry fibre is then submitted to the action of a "willow" or "devil," by means of which it is opened or "teased" out, and converted readily into a tow-like condition, when it is dried by a current of heated air, induced by a fan-blast, and finally baled up for storage or transport. In this condition of paper-stock it may be kept for an indefinite length of time without injury; and when received by the paper-manufacturer, it has only to be soaked down and bleached, in order to fit it for making paper, either by itself or as a blend with other materials.

A second material which, in Mr. Routledge's opinion, fulfils the main conditions demanded by a paper-manufacturer is "megasse," or "begasse," the fibrous residue of the sugar-cane after it has been crushed to extract the juice. This, when "properly prepared, affords a strong, nervous fibre, or fibrous stock, which bleaches well and possesses all the characteristics of a first-class paper-making material." For obvious reasons, megasse would also have to be "converted into a fibrous stock at or near the sugar-factory where it is produced, then dried, and put up in hydraulic-pressed bales for economical transport." At present, megasse is only made use of as fuel in the sugar factories, and in some countries as manure. "As its value, thus considered, is very low," Mr. Routledge thinks that "factories established in connection with existing sugar-mills for the manufacture of paper-stock, where sufficient quantities of so bulky a material could be concentrated, and where other favorable conditions exist (of which an abundant supply of water is an essential), would yield a large profit to the planter or sugar manufacturer;" indeed, he has "made both paper-stock and paper of good quality from megasse, and determined the profitable nature of such a manufacture beyond dispute." Bamboo and megasse yield sixty and forty per cent of fibre respectively.

THE SCREW-PROPELLER IN NATURE.

By ALFRED GEORGE RENSHAW.

Now that the question of the best form of the screw as a propeller has become of such importance, it is interesting to note what nature has done in this direction.

The seed of the ash (*Fraxinus excelsior*) is provided with a wing very delicately twisted, and, when the seed falls, the action of the air upon this screw-like wing causes it to revolve rapidly. The result is that the seed is kept suspended in the air for a comparatively long time, and is wafted by the slightest breeze to a considerable distance from the parent tree. I do not know that this peculiarity is referred to in any botanical work, but it very beautifully fulfils the object which characterizes more completely the lighter-winged seeds—namely, the dispersion of the seed beyond the limits of the plant or tree which bears it.

I am not by any means sure that the screw on the ash-seed will not *by its own action*, independently of any wind, work itself away, in its fall, from the perpendicular line. But when the wind blows strongly—and it takes a strong wind to blow the seeds off at all—their range is very extensive.

The seeds hang stubbornly to the tree through the winter months, reserving themselves for the March gales, of which the wind-fertilizing plants avail themselves so largely.

I should much like to know if any of your readers have observed this screw and studied its pitch, and it would be very remarkable should it prove that the pitch of this natural screw is the one which will give the most power to the propeller of a steamer.

The seeds of the maple and the sycamore have somewhat similar appendages, but the screw is, in neither case, so marked. If any one, at this season, will throw up a stick at the seed-clusters of ash, maple, or sycamore, he will find the seeds come fluttering to the ground like a cloud of butterflies, and alighting quite as softly on the ground.—*Nature.*

PAREMENTINE.

AN improved size, invented by Mr. E. Torlotin, of Paris, and to which this name has been given, consists of 100 parts gelatinous glue dissolved in the smallest possible quantity of water, to which is added 70 parts of dextrine, 20 parts of glycerine, 20 parts of sulphate of magnesia, and 20 parts of sulphate of zinc; the whole must be well mixed together, and is then left to dry in moulds, after which it will be ready for use.